

## THE EARLY ACQUISITION OF SEGMENT SPECIFICATION

The evolution of the child's phonological system, in particular the development of the articulatory and categorial gesture, with reference to English and Dutch.

Anita C. Heijkoop

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In memoriam

*Anne Monquil*

*Helena Wilhelmina van Helden*

*Olivier*

For

*J.N. Heijkoop*



I hereby declare that this thesis has been composed by myself, and that the work is my own unless otherwise indicated.

Anita C. Heijkoop  
Edinburgh

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## *Abstract*

This thesis is concerned with early phonological development and segmental representation, on the basis of spontaneous longitudinal data. In part I, the assumptions underlying the research are formulated on the basis of a brief discussion of existing literature regarding the child's innate endowment to acquire language, early cognitive development, the origin and character of pre-phonological structure, the nature of an appropriate perception/production model and the role of phonological processes in the acquisition process. Also, main topics in the acquisition literature relevant to phonology are evaluated, such as word patterns, consonant harmony and reduplication. Early phonological acquisition is considered to be a cognitive process, constructivist in nature, with some innate constraints that function as attention-biases. It is assumed that the child has a perception-based representation, constructed on the basis of his own abilities, and that subsequent representational redescription results in his phonological representation.

In part II, the data of five Dutch and two English children between 1;0.10-1;6.4, recorded regularly during the period of a year, constituted the basis for the reconstruction of the evolution of the phonological system of each child. To this end, the phonological contrasts for each recording session for each child were established on the basis of the child's phones, diachronic development of the child forms and their relation to the target word, following clinical methods. Clear trends were identified that characterised the acquisition scenarios of all children studied (see below). From the data analysis, the development of place of articulation and the recurrent CV(CV...) structure also emerged as outstanding features of the child's early output. The observed highly variable place realisation in the child forms can be accounted for as a direct consequence of the state of development of the child's phonological system, i.e. the contrasts present. Early specification of labial and subsequent alveolar/velar variation explain the variability observed in terms of non-contrastive variability and labial filling-in. The application of the assumption of coronal underspecification to child language is investigated and subsequently rejected on the basis of its incorrect predictions and the unsound evidence quoted. In the data, there was strong support for the CV sequence as basic unit. The child can apply a variety of strategies that ensure CV compliance, such as inserting dummy consonants, filling-in of non-specified slots, breaking-up and reduction of clusters, and interaction across words. Consonant harmony and reduplication can also be regarded as protostructure strategies. Overall, the CV

structure embodies a basic structure that enables the child to classify perceptual information in a functionally relevant way.

Part III focuses on the representation of early phonological development. The suitability of different notational models is examined with reference to the trends identified in the evolution of the child's phonological system. Those aspects of notation that are relevant to the acquisition of phonology are discussed in relation to binary features, feature geometry, dependency phonology, radical CV phonology and articulatory phonology. The development of manner of articulation is observed to proceed in terms of contrast; the order in which the natural classes are acquired is predictable on the basis of the (maximally different) degree of sonority. This development is most insightfully expressed by means of (the preponderance of)  $|V|$  components expressing sonority as proposed for the categorial gesture in dependency phonology. Regarding place development (see above), a detailed analysis of consonant-vowel interaction made it clear that the CV harmony assumption (for labial, coronal and dorsal) was not confirmed by the data. The articulatory characterisation in dependency phonology can express (the acquisition of) the three main places of articulation adequately by means of a labial and lingual place component.

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- the age of a child is expressed in years:months.days, e.g. 1;4.12.
- data recording sessions are indicated by means of #, e.g. #16.
- the reference to particular children is presented in bold; child numbers for the ChildPhon data and letters for the Cruttenden corpus, e.g. **8**, **L**.
- the target word (or phrase) is presented in italics, e.g. *mu:s*.
- single quotations marks enclose the gloss(es) of the target word, e.g. 'mouse'.  
(If glosses for the Dutch acquisition forms are not included in the ChildPhon database, the glossary in Fikkert (1994), Appendix B, has been consulted.)
- the phonetic symbols are presented in IPA Kiel font.
- square brackets enclose the child realisation, e.g. [mʌmʌ].
- slanted brackets enclose the adult phonemic form, e.g. /mœys/.
- the underlining of part of a target phrase indicates a limitation of the discussion, translation, transcription, etc. to that part of the target.
- the main parts in this thesis are referred to by means of capital Roman numerals, e.g. II.
- the sections within the main parts are referred to by means of numbers followed by a full stop, e.g. 4..

(When reference is made to a section outwith the main part in which the reference is made or in a footnote, the reference to the main part is included, e.g. III4..)

- figures, tables, data examples, etc. are referred to by means of numbers; when occurring in the main text, these numbers are enclosed in parentheses, e.g. (6).
- *above* and *below* refer to the preceding and following discussion, respectively, within a section.
- within a section, underlining indicates a sub-division into sub-sections that constitute a list.
- in the text, paragraphs either are or are not separated by a blank line, indicated lesser and greater coherence between the contents of successive paragraphs, respectively.
- reference to *Anderson* in the text is to Anderson, J.M.; reference to *Levelt* is to Levelt, C.C..
- in the case of references including an author with particles preceding the main name, only the main name will be presented with an initial capital letter, e.g. van der Hulst; in the bibliography, such a name is listed alphabetically under the main name, e.g. Hulst, H. van der.

## Introduction

This thesis presents a study into the early acquisition of the child's segmental specification and the development of his phonological system.<sup>1</sup> It has basically evolved from the query how (the adult's) phonology comes into being. The study entails an analysis of longitudinal, spontaneous data of seven children between 1-2½ years, and a discussion on the representation of the development and phonological phenomena observed. As such, this study can be considered to contribute to the filling in of the gap that is caused by the lack of interaction between mainstream phonological theory and the study of phonological development, observed by Donegan (1995), in the child language field.

More specifically, the study here aims to make a contribution to the understanding of early phonological acquisition within a framework that is not based on merely descriptive methods, and, secondly, that does not attempt to describe child language by means of the extension of adult phenomena, theory and structure. This objective has arisen, on the one hand, from an *a priori* assumption regarding the child's autonomy as a language learner, and, on the other, as a reaction to the existing literature. Namely,

much of literature [concerning language acquisition] is purely descriptive statements of what learners do, specifically of what they produce. And these descriptions of production have typically failed to illuminate the process of acquisition or the nature of the representational symbol structures that underlie language (Macken 1992:253-54).

The examination of the early acquisition of segment specification here involves reconstruction of the evolution of the child's phonological system, based on the contrasts as they become evident from his output. The child's utterances are considered here to be 'the only evidence from which to reach conclusions about underlying knowledge' (Elbers and Wijnen 1992:361 after de Villiers 1988).

Another perspective from which acquisition proposals can be regarded as being descriptive is the explanation of the acquisition process by means of processing strategies, rather than acquiring strategies (Nelson 1973). Processing strategies are considered to involve the matching of elements to existing structure, whereas the addition of new elements to existing structure, i.e. acquiring strategies, is regarded as being the essence of acquisition (1973:5). Processing strategies appear to

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<sup>1</sup> Here, and throughout the text, *he* is used as a third person pronoun that is unmarked for gender.

be directly related to phonological processes or rules, a widely applied acquisitional mechanism, which basically state the relationship between the phonemic representation of the (adult) target and the child's realisation of that target. For these processes to have any reality in the acquisition process, the adult representation would have to be assumed to be part of the child's lexicon (for a discussion, see I4.), whilst there is no evidence in the child's output for this assumption (see above). This clearly indicates an adult-based view on acquisition, amongst other things. In Menn's (1980) terms, it reflects a centre-based approach to child language as 'the general equation of the center of psychological fields [is] with the study of adults and the relegation of developmental studies to [the] periphery' (1980:24).

The extension of adult phenomena, and consequently of adult structure, to acquisition observations appears to be another phenomenon that is centre-based, rather than "peripheral", or child-based, in its outlook. Clearly, the language (structure) of the child develops into adult language, and a representational model is expected to have the ability to account for and represent this development as a continuous process. This is basically why the (description of the) early stages of language acquisition are assumed to be relevant to language theory, or, in the context of the study here, to the notational models of phonology. However, to extend certain adult phenomena backwards (cf. Menn 1982) and impose them on child language can not be regarded as being part of this continuity hypothesis. For example, the (coronal) underspecification claim is based on observations in adult language. Only on the basis of similar observations in the context of similar language structure is it assumed here to be permissible to extend underspecification (in the Archangelian sense; cf. Archangeli 1988) to other language varieties (see II4.).

This study acknowledges the autonomy of the child's development and his phonological structure, and can therefore be considered to depart and proceed from a child perspective. In order to arrive at a broad base of assumptions to support the data analysis into early phonological acquisition, various aspects are discussed in part I on the basis of the existing literature. Assumptions are formulated regarding innateness, developmental (cognitive) constraints, pre-phonological development and structure, and a perception/production model. Part I thus sketches a general scenario of early phonological acquisition to serve as the context for the investigation into the acquisition of segmental specification. It also discusses general acquisition phenomena as reported in the literature, namely consonant harmony, reduplication and wordpatterns. This provides an

insight into the nature of the acquisition process as presented in the literature, as well as an understanding of the requirements of a model of phonological development.

The aim of the data analysis in II is to make possible a discussion of the characterisation of early phonological development, and to that end, an observation of (the phonetic representation of) the child's utterances (obviously) does not suffice. In order to investigate the acquisition of the child's phonological system, a method has been formulated, on the basis of clinical methods, to reconstruct the phonological contrasts for each child, for each recording session. Furthermore, a rich source of data was found in the ChildPhon database, which offers longitudinal data of 12 children between 1-2½ years, acquiring Dutch. This data was complemented by the Cruttenden corpus with longitudinal data from the early utterances of two English children. On this basis, the evolution of the phonological system was reconstructed. This approach has the advantages of a longitudinal study, which makes possible an in-depth rather than an anecdotal account of development, and of a study based on the utterances of a small number of children, which makes it possible to make observations that are sufficiently specific to be realistic (cf. Moskowitz 1971), and sufficiently general to be valid.

The discussion of the data constitutes the major second part of II. The choice of aspects investigated is motivated by the phenomena that are salient in the data, which were also topics that evolved from or could be linked with the literature, in most cases. The acquisition of place, and the assumption of underspecification and its consequences are discussed in the context of the ChildPhon data. The child's adherence to the CV unit in his output is examined, and related to the production of [h] and glottal stop, the child's protostructure and its "application", and reduplication. The overall goal of the data discussion in II is to attain a better insight into the phenomena that become evident from the data in relation to the acquisition of phonology, and to determine the role of these phenomena in the acquisition process.

Part III presents an investigation into the relation between notation and phonological acquisition. As indicated above, mainstream adult phonological theory has been extended to (the representation of) child language (a perspective from the centre to the periphery). However, on the assumption that models of language acquisition, including notational models of phonology, should be able to adequately represent the early stages of the acquisition process, and also that these

stages are relevant to the design of notational models, the suitability of different phonological models is evaluated on the basis of the evolution of the phonological system of the child, as reconstructed and discussed in II. For some notational models, the interrelation between phonological theory and early acquisition is a basic element of the model itself (e.g. articulatory phonology), whereas other models are based solely on observations in adult language (e.g. binary features, feature geometry). The models that are evaluated in relation to early phonological development are binary features, feature geometry, dependency phonology, radical CV phonology and articulatory phonology.

## I PROLEGOMENA

Before introducing, analysing and discussing (the early phonological development evidenced in) the longitudinal data of five Dutch and two English children (II), the discussion in this section aims at formulating a plausible set of assumptions regarding child language issues, in general, and the acquisition of the child's phonological system, in particular. The outcome of this discussion will subsequently underlie the research reported in this thesis. The investigation of the different acquisitional aspects is by no means intended to be exhaustive (the aspects of the relationship between perception and production, and the child's early cognitive development, for instance, are merely outlined). Rather, it attempts to arrive at a well-founded broad assumption concerning early phonological development to serve as the base from which an understanding of the acquisition data can develop through the data analysis conducted in II and the representational implications of the outcome in III.

In 1., a brief and concise account is presented reflecting the discussion in the literature regarding the child's innate endowment to acquire language. The main points of this debate are repeated and considered here (for a full discussion, see the references provided). In order to arrive at an innateness assumption that is to be part of the broad basis assumption that this section (I) sets out to formulate, the literature on early cognitive development is taken into account (2.). This, in turn, raises the question whether cognitive findings from different developmental domains (e.g. numbers, syntax) are comparable. In particular, many studies are concerned with the child's semantic development, and the possibility of a parallel development of the child's early phonological and semantic skills is investigated (3.). As becomes clear, this also relates to the nature of pre-phonological structure, and the development of the child's representation that reflects his understanding of the world, on the one hand, and his (pre-) phonological structure, on the other.

The relationship between perception and production is briefly discussed as it relates to the assumption of phonological processes, namely that the child has an adult-based representation of the target word. It also bears upon the (nature of the) child's processing of the speech sound. An appropriate perception/production model, designed with the child's perspective in mind, is presented, which can incorporate the cognitive notion of representational redescription (4.).



Finally, the following topics are discussed: wordpatterns, consonant harmony and reduplication (5.-7., respectively), on the basis of the acquisition literature. These discussions contribute to a better understanding of what is required of an adequate account of phonological acquisition, and serve as points of reference for the data discussion in II.

## 1. Innateness

*'What mechanisms are available to the human infant at birth that may predispose the infant to the acquisition of speech'* (Menyuk 1977:24). What, if any, language structure is assumed to be present in the child's mind at birth, what innate equipment does he bring to the task of language acquisition? What is the role of the child's (linguistic) environment in order for him to learn to speak like the members of his speech community?

The main characters in the centrestage innateness debate are Jean Piaget and Noam Chomsky. Their proposals, reflecting constructivism and nativism, respectively, are outlined below. These views are discussed and amended in Pinker (1994) and Karmiloff-Smith (1993), amongst others. The opinions regarding the child's innate mechanisms for language acquisition of these four authors are given below (1.1). This constitutes the basis for a brief and general discussion on innateness in relation to language acquisition (1.2).

### 1.1 **Innate v. learned**

**Piaget:** In Piaget's view, the environment is of paramount importance for learning. The child does not simply observe, record and consequently learn from the world around him; there is a continuous interaction between the child ('s mind) and his environment. On the basis of this interaction, the child acquires knowledge of the world around him through his active involvement in the reconstruction of that world, namely 'through an organization of successive actions performed on objects' (Piaget 1980:23) (see below). Piaget does not assume any innate cognitive structures. Instead, the child is assumed to inherit the functioning of intelligence that creates and co-ordinates cognitive structures (Smith and Cowie 1991:319, Piaget 1980:23). These structures are referred to as *schemes*, which grow and change in the course of the child's development in accordance with the child's knowledge. The actions referred to above are responsible for this:

Knowledge ... proceeds from action, and all action that is repeated or generalized through application to new objects engenders by this very fact a "scheme", that is, a kind of practical concept. The fundamental relationship that constitutes all knowledge is not, therefore, a mere "association" between objects, ... but rather the "assimilation" of objects to the schemes of that subject. ... Conversely, when objects are assimilated to schemes of action, there is a necessary "adaptation" to the particularities of these objects ... , and this adaptation results from external data, hence from experience (1980:24).

The child thus acquires knowledge through active interaction with the world, and subsequent assimilation, and adaptation of his schemes when disequilibrium of his scheme occurs as a

consequence of assimilating new experiences that disturb the existing equilibrium. 'The striving for balance between assimilation and accommodation [i.e. adaptation] results in the child's intrinsic motivation to learn' (Smith and Cowie 1991:320). The child's mental growth and mode of thinking go through a number of stages of development, corresponding to changes in the structure of his intelligence. Piaget proposes four stages that occur in a fixed order in the development of the child (the sensori-motor, pre-operational, concrete operational, and formal operational stages) (1991:318-19).

For Piaget, the child is an active and constructive agent that slowly acquires knowledge through interaction 'between certain inborn modes of processing available to the young child and the actual characteristics of physical objects and events' (Gardner 1980:xxvii). Language is also acquired by means of these general processes. The processes of assimilation and adaptation are innately available to him; no innate knowledge, nor a language-specific component is assumed.

Chomsky: According to Chomsky, at birth, a child basically possesses all the mental structure he needs for his linguistic life. This rich innate endowment includes a conceptual framework, as well as a system of assumptions about sound structure and the structure of more complex utterances (Chomsky 1988:34). Indeed, 'the essential knowledge about language is specified by one's genome, [and] nearly all possible hypotheses about the rules of syntax [for instance] that the child might conceivably invent are precluded by the human generic inheritance' (Gardner 1980:xxx).

Part of the basis for this view is arrived at through the discussion of a solution to *Plato's problem*. This is the problem of explaining the chasm between the rich system of knowledge of language that is observed in humans, on the one hand, and the poverty of the stimulus, i.e. the evidence that is presented to people in their environment, on the other (Chomsky 1986:xxv, 7). Chomsky's proposal concerning Universal Grammar is an answer to Plato's problem (Chomsky 1988:62). Universal Grammar is based on the assumption that all human languages share a common core of properties, and its goal is to determine these universal principles, as well as the parameters that express the variation between the grammars of different languages.

the "core properties" of [the principles and parameters model of Universal Grammar] which languages share are of such an abstract nature that they are not "learnable" simply on the basis of exposure to the kind of *linguistic experience* (= speech input) which the child receives. [Chomsky] therefore concludes that these "universal properties" of language must be part of the child's genetic endowment, and that children are born with an innate knowledge of Universal Grammar ... (Radford 1990:5).

Universal Grammar can thus be regarded as the ‘characterization of the genetically determined language faculty’ or a language acquisition device that reflects the child’s intrinsic competence (Chomsky 1986:3). Language acquisition, in this context, entails the development of “performance systems” by the child for putting the innate knowledge to use (Chomsky 1980:35). Exposing the child(’s language faculty) to data, i.e. a particular language, will yield the grammar of that particular language and alter the state of the language faculty from its initial state by parameter setting (Chomsky 1988:61).

With regard to the efforts on the part of the child in the process of acquiring language, these are regarded as minimal, or even absent, as the whole process does not require conscious attention or choice (Chomsky 1986:51). The development of the human mental capacity, which includes the ability to learn language, is predetermined: ‘[t]here is a fixed initial state ... of the language faculty consisting of a system of principles associated with certain parameters of variation and a markedness system’ (1986:221). On this basis, language is not something the child learns, the acquisition of a language just happens to him (Chomsky 1988:173). What is required for the “language acquisition” of the child is experience of the language, which will trigger the mind to work in its predetermined way (1988:172, Gardner 1980:xxx). This will affect the child’s language structure in the form of setting the parameters that reflect inter-language variation. The role of the environment, in Chomsky’s view, is thus minimal, and the interaction between the organism and the environment is not considered to be relevant to the child’s mental structure (1980:xxx, Chomsky 1980:51-52).

... the environment per se has no structure, or at least none that is *directly* assimilable by the organism. All laws of order, whether they are biological, cognitive, or linguistic, come from inside, and order is *imposed* upon the perceptual world, not *derived* from it. These laws of order are assumed to be species-specific, invariant over time and across individuals and cultures ... (Piattelli-Palmarini 1980b:10).

Following the Universal Grammar theory, the child is thus regarded as being born with a specific language faculty that contains all necessary language structure for the child (Chomsky 1988:47). Exposure to language will trigger the grammar of that particular language to be formed by means of setting the parameters of variation. This fixing of knowledge is a predetermined and non-constructivist process. Only in this way can Plato’s problem be solved according to Chomsky, and can the discrepancy between children’s limited and varying experience of language, and their comparable and complicated grammars be understood (Chomsky 1980:35).

Pinker: The child is regarded as a conservative hypothesis tester, in Pinker (1994), who will ‘start with the smallest hypothesis about the language that is consistent with what parents say, then expand it outward as the evidence requires’ (1994:282) (see below). Pinker appears to adopt the general idea of Universal Grammar. However, the acquisition process is not entirely assumed to be an innate process; language is partially learned. One of the reasons why a fully innate language structure is not favoured is the social dimension. Given that language ‘inherently involves sharing a code with other people’ (1994:243), there is no point in having a complete grammar from birth on if this grammar is not shared by the speakers in your environment. There thus seems to be a need for variable parts of the grammar, which ensures that the child’s grammar is synchronised with that of others in the speech community (cf. 1994:277), and thus renders it useful.

Pinker discusses the break-point between innate and learned information, and his views are less rigidly nativist than Chomsky’s. Generally, as more of the child’s grammar is innate, it is less likely that the language acquisition will fail. Consequently, there is less pressure to replace what can be learned with innate, neural “knowledge” (analogous with computer simulations, 1994:243). Indeed, what Pinker proposes is an innate, basic design of language that leaves space for the child to work out the exact state of affairs on basis of his language input (1994:243), i.e. hypothesis space (see below). This is different from the parameter model proposed by Chomsky (see above) in that with regard to, for example, the order of noun and adjective, the child is innately equipped with the basic units Noun and Adjective, and a notion concerning the order of segments (Pinker 1994:243), rather than specific parameter-bound options (Noun-Adjective, Adjective-Noun, both). As such, innate language structure is considered to provide a flexible system of learning, as the child that is constrained by innate grammar structure has a powerful tool to acquire language, according to Pinker (1994), and knows what information in his input to focus on in order to construct and acquire a language (1994:287-88). The mental flexibility that is advocated in constructivist proposals (Piaget, Karmiloff-Smith) is considered to confine children. For instance, the child that can mentally label *the park* as a Noun Phrase in the phrase *the tree in the park* has gained the insight that an NP can occur inside a Prepositional Phrase inside an NP. A child who ‘[is] free to label *in the park* as one kind of phrase and *the tree in the park* as another kind would

be deprived of the insight that the phrase contains an example of itself, and is thus regarded as being confined (1994:287).

Pinker (1994) rejects a 'generalized tendency to learn' (1994:415) as sufficient. The "language instinct" is reflected in the mind as various modules that are specific to language and ensure that, for instance, different categories and phrase structure principles are innately known to the child (1994:287, 419).

[T]he child is assumed to know, prior to acquiring a language, the overall structure of the grammar, the formal nature of the different sort of rules it contains, and the primitives from which those rules may be composed (Pinker 1984:31).

Part of the innate structure concerns a notion of similarity that enables the child to generalise a specific sentence to another sentence in the child's output (*John likes fish* is similar to *Mary eats apples*, and different from *John might fish*). Pinker (1994) argues that 'learning a grammar from examples requires a special similarity space (defined by Universal Grammar)' (1994:417). Furthermore, it is claimed that different modules have different similarity spaces which allow those modules to generalise in some domain of knowledge (1994:418).

With regard to the origin of the different parts (syntax, morphology, speech perception, etc.) of the child's innate grammar, Pinker (1994) points to the evolutionary adaptation of language. 'Those parts are physically realized as intrinsically structured neural circuits, laid down by a cascade of precisely timed genetic events' (1994:362), and ultimately by natural selection. The division of labour between the different modules and their different principles of "similarity" are also linked with Darwin's evolution idea. This is illustrated by a passage from Quine (1969).

... why does our innate subjective spacing of qualities accord so well with the functionally relevant groupings in nature as to make our inductions tend to come out right? Why should our subjective spacing of qualities have a special purchase on nature and a lien on the future?

There is some encouragement in Darwin. If people's innate spacing of qualities is a gene-linked trait, then the spacing that has made for the most successful inductions will have tended to predominate through natural selection. Creatures inveterately wrong in their inductions have a pathetic but praiseworthy tendency to die before reproducing their kind (Quine 1969 in Pinker 1994:418).

Karmiloff-Smith: Karmiloff-Smith (1993) explicitly adheres to both nativist and constructivist elements in her epistemological account of (language) acquisition. Nativism and constructivism are claimed to be not necessarily incompatible (1993:563), and there are reasons to contain both



in a theory of learning. The active role that Piaget attributed to the child as participant in his own ontogenesis, and his constructivist view of knowledge are considered to be a viable way to think about development. It makes it possible to express the cognitive flexibility and creativity that characterise early child development (1993:566). However, to regard the young child as being 'a purely sensimotor organism with nothing more to start life than a few sensory reflexes and three ill-defined processes: [a]ssimilation, accommodation, and equilibrium' (1993:564) is not satisfactory according to Karmiloff-Smith. The reason for this is the data available on neonates and infants that points to the existence of innately-constrained, domain-specific attention biases (1993:564). For example, research on face recognition by new-born infants suggests that the child distinguishes between different face-like patterns (in terms of three high-contrast blobs: eyes and mouth) (1993:565-66). With experience, the child will fill in the details of the human face. It is thus concluded that a nativist stance is appropriate with regard to the initial structure of the child's mind, and that for 'a comprehensive account of human development one must invoke *both* innately-specified predispositions and a constructivist view of development' (1993:566).

In Karmiloff-Smith's view, *specific* innately-specified dispositions require the environment mainly as a trigger to determine a choice from alternatives, comparable to Chomsky's parameter setting (see above). For *non-specific* dispositions, the environment 'actually influences the subsequent structure of the brain via a rich epigenetic interaction between mind and physical/sociocultural environments' (1993:569). The initial structure takes the form of innately specified information that channels the child's attention (to persons, objects, space, cause-effect relations, number, language, etc.) in the case of non-specific dispositions. This gives rise to domain-specific representations as the child's gains experience from its environment, i.e. learning. The environment is paramount to the child's development, both for his innate abilities (focus on certain aspects of this environment or parameter setting) and subsequent learning as it affects his brain structure (1993:566). (For a more detailed account of Karmiloff-Smith's views, see 2.4.)

With regard to the inclusion of both nativist and constructivist elements in her proposal of development, Karmiloff-Smith (1993:566) notes the following (cf. Pinker (1994) above):

... human cognition manifests flexibility and creativity with development. Now, it is true that the greater the amount of primitively fixed formal properties of the infant mind, the more constrained its computational system will be (Chomsky 1988). In other words there is a trade-off between the efficiency and automaticity of the infant's innately specified systems, on the one hand, and the rigidity of such systems, on the other. But if systems were to remain rigid, there would be little if any room for cognitive flexibility and creativity.

## 1.2 Discussion

With regard to the (language) acquisition proposals of Piaget and Chomsky, their common core is summarised in Piattelli-Palmarini (1980a:54) as follows:

- i) nothing is knowable unless cognitive organisation of some kind is there from the start; and
- ii) nothing is knowable unless the subject acts, in one way or another, on the surrounding world.

Assuming an axis comprising these two assumptions and reflecting the degree of innate structure that is presupposed when a child is born, the proposals by Piaget and Chomsky can be placed at opposite ends (1).<sup>1</sup> Their views as discussed (1.1) are summarised below.

(1)	Chomsky	<i>Pinker</i>		<i>Karmiloff-Smith</i>		Piaget
	INNATE					LEARNED
	most innate structure	more structure less hypothesis space	↔	less structure more structure built by child		least innate structure
	<b>child undergoes automatic parameter setting</b>					<b>child is inventor and active interactor with environment</b>
	<b>LANGUAGE ACQUISITION</b>					

In Chomsky's view, the child undergoes language acquisition as the parameters get set automatically once the child is exposed to language. Universal Grammar (UG) is shared by all natural languages, and reflects the innate language structure in the child's mind. Plato's problem, i.e. the discrepancy between the child's language expertise and the poor evidence from the language environment, is thus solved by assuming all structure is there at birth and parameter choices are "switched" automatically to the correct position. According to Piaget, the child can handle Plato's problem by means of the assimilation and adaptation of his schemes on the basis of the environment. The child is regarded as an active interactor with his environment, and characteristically his mental capacities are flexible and creative. The images of the child as

<sup>1</sup> At the extreme end of the axis, next to Piaget, the empiricists can be placed. Their analogue of the child and his (language) acquisition process is in terms of a *tabula rasa* or blank slate: 'knowledge ... [is] a product of living in an environment, a series of messages of "nurture" transmitted by other individuals and one's surrounding culture, which become etched on a *tabula rasa*' (Gardner 1980:xxvii).



automatic switch-regulated speaker and constructive inventor of schemes are discussed and moderated in Pinker (1994) and Karmiloff-Smith (1993), respectively.

Pinker (1994) adheres to the broad UG scenario of language acquisition. The evolution of innate structure through natural selection is emphasised. Generally, he assumes that there is a (limited) hypothesis space available to the child and that some structure is decided on by the child. Language acquisition, however, requires more than general learning strategies. For instance, the order of categories in sentence structure is discovered by the child by means of innate equipment comprising the notion of (word) order and the identity of the categories. So, where Chomsky assumes innate parameters, Pinker proposes slightly more flexible, evolutionary, and innately rich acquisition structure specific for language. The emphasis in Karmiloff-Smith's (1993) discussion of acquisition is on the flexibility and creativity of the mind. She proposes a largely constructivist scenario with innate constraints in the form of biases that channel the attention of the child. Overall, knowledge is acquired and built up through the child's observations of the environment (and subsequent representational redescription). Language is assumed to be acquired by means of general learning mechanisms.

Taking these four proposals into account, different pictures emerge of what constitutes learning and the role of the child therein: "language acquisition happens to the child through language-specific structure", "the child has elaborate innate structure and innate strategies to test and learn language", "the attention of the child is innately channelled and language is acquired on the basis of environment-child interaction, and "all that the child requires is the environment and his innate strategies of assimilation and adaptation; no innate language structure is assumed". Also, whereas Piaget and Karmiloff-Smith base their proposals on factual child observations and acquisition research, Chomsky adopts abstract adult language structure as the basic evidence of the acquisition process that he proposes.

So, regarding the innate-learned axis (Figure 1), the child's autonomous part in the language acquisition process or the child's active "participation" in solving Plato's problem decreases from the cognitive to the innate extreme (from right to left). The initial questions can now be rephrased, and remain largely unanswered: what is the balance between the child's capacity to "discover" language and the (language) structure present at birth?

Besides the two general assumptions that are valid for all proposals on the innate-learned axis (see above), Pinker and Karmiloff-Smith both advocate a view on language acquisition that regards the child's equipment as being a combination of innate structure (including or mainly attention focusing devices, respectively) and subsequent learning through hypothesis testing on basis of his input. Different relative weight is given to the elements of the innate-learned balance. In this sense, the child in Pinker's acquisition scenario appears to have more innate constraints, whereas Karmiloff-Smith regards the child as having more space to hypothesise and invent.

The basis for the considerations that are taken into account here regarding the innateness issue is the research into early cognitive development, discussed in 2., that strongly emphasises the cognitive abilities of the child (e.g. Cromer, Mandler, Nelson). In this context, the balance struck by the proposal in Karmiloff-Smith (1993) is regarded as an appropriate way to view the acquisition process (cf. 2.6). It is thus adopted as the innateness assumption concerning language acquisition underlying the research here.

## 2. Early cognitive development

### 2.1 **Internal factors and environment**

Cromer (1991) discusses the acquisition of language structure. It is concerned with the directions taken by language acquisition research that, it is claimed, '[lacks] an adequate understanding not only of language acquisition but of cognitive development in general' (1991:191), due to conceptual prejudices. Cromer (1991) proposes two ways in which proposals expressing these prejudices could be reconceptualised. The first is relevant to the discussion here and is discussed here, unlike the second. It addresses innate factors and the language system as 'a conceptual puzzle space to be dealt with in its own right' (1991:192).

Cromer (1991:218) states that a theory of language acquisition or, for that matter, any account of cognitive development, relying almost exclusively on external influences will not be adequate. Instead, development should be regarded as the interaction of inner determinants and environmental factors. According to Cromer, 'it is possible to conceive of theories of development that place a greater emphasis on epigenetic-interactionist principles and that take species-specific structures and functions into account' (1991:224), where *epigenetic-interactionist* signifies the claim that 'there is inherent in the human species a number of unfolding developmental phenomena, some of which may be specifically linguistic, that interact with environmental variables' (1991:220).

To assume that certain structures are innate in the human species does not imply that children possess these structures when born. It means that they are built up 'from an interaction of innate potential with environmental factors' (1991:220-21). Environmental interaction is illustrated by the development of receptors in cats' eyes (1991:223); cats have inborn receptors for horizontal and vertical stimuli. In an experiment, cats were raised in either a vertically or a horizontally striped environment for five months to investigate how cells developed functionally. The neurons in the cat eyes developed in response to the environment; the adult neurons were all responding within 45 degrees of the expected orientation. It was thus concluded that the orientation of the receptive fields can be modified by experience. (See also Aslin and Pisone (1980) on orthogenetic functions.)

It seems then, that inborn biological structures that are genetically determined are very much affected by environmental experience. Such environmental effects are within limits, however. Cells responding to linear orientation can be made to react to specific orientations in accordance with environmental experience, but those same cells do not respond to other aspects of visual input (Cromer 1991:223-24).

The “mixture” of external and internal influence of the developmental process that Cromer advocates he appears to have found in the model proposed by Karmiloff-Smith. ‘Her experimentally based work demonstrates the advantages of viewing the child as an active organism with internally generated procedures and operations addressing himself to the linguistic system as a problem space to be solved’ (1991:215). Children’s motivation to engage themselves in this “problem” is claimed to be an attempt ‘to come to terms with their own budding organizational activities, language, and all of their environment, and is not driven by communication purposes’ (1991:233). For a discussion of the Karmiloff-Smith proposal see 2.4.

So, a model accounting for cognitive development can thus be assumed to comprise innate factors that interact with the environment. The theoretical tension between external and internal aspects can be envisaged to be in terms of an axis expressing the relative distribution of the environment and innate factors. Perpendicularly placed on this innate/environment axis, a language-specific/general axis can be placed, expressing the extent to which the acquisitional problem space of language is dealt with by specific acquisition principles and/or general cognitive development (Morag Donaldson, personal conversation).

## 2.2 Constraints

Bowerman (1993) discusses the development of cognitive theory in the context of predispositions for semantic organisation, after the initial reaction to Chomsky’s nativist view that rejects the behaviourist theory of learning. Cognitive theory emphasises the child’s growing conceptual knowledge. During the prelinguistic period, basic notions (objects, actions, causality, spatial relations, etc.) are acquired by the child. Later, ‘[a]s children begin to want to communicate’ (1993:329), linguistic forms will encode these notions. Initial development ‘is a process of learning to map linguistic forms onto pre-established concepts, and these concepts, in turn, at first serve to guide the child’s generalisation of the forms to new contexts’ (1993:329) (cf. 2.5). It has also been argued that (linguistic) generalisations discovered by the child can help in developing cognitive concepts. So, there is not just a one way sequence of events, rather, concepts and discoveries about, for instance, regularities in the world offer “cross-help” (cf. Gopnik and Choi 1990).

On basis of the initial semantic categories observed in children and the similarities across languages, nativist elements have been adopted in the cognitive view. Rather than regarding the

conceptualising and classifying of the child's experience as 'free to vary arbitrarily', these are assumed to be shaped and constrained by inherent properties of the perceptual and cognitive system; 'children's early categories may be "learned" in the sense that experience is required to set their development in motion, but they will develop in a relatively uniform way despite exposure to different linguistic and nonlinguistic environments' (Bowerman 1993:330).

The nature of these inherent properties that shape and constrain the observations of the child of the world around him and relevant to the child's outlook on that world might be related to the notion of *constraint*. Keil (1990) evaluates four different proposals regarding constraints and the extent to which they are assumed innate and/or domain-specific.

... the broadest possible definition of constraints would simply be any factors intrinsic to a learner that result in a nonrandom selection of the logically possible characterisations of an informational pattern (1990:136).

Domain specific constraints are predicated on specific sorts of knowledge types; it is not so that all possible learning input is constrained and/or constrained to the same degree. The working definition of domain is in terms of patterns of learning; '[i]f ... restrictions on possible hypotheses are unique to a specific body of the knowledge, that knowledge is considered a domain' (1990:139).

An argument supporting the adoption of constraints is discussed in Keil (1990), following Pierce (1931-35), and concerns the problem of induction:

... [it was illustrated that] learning through induction was doomed in an organism that did not possess a priori biases on hypothesis generation; biases that had acquired an affinity with environmental regularities through the process of natural selection. For virtually any naturalistic learning situation, it is easy to formally demonstrate the indefinitely large number of different hypotheses that can be made over a set of data (Keil 1990:136).

Markman (1990) phrases it as follows: '... humans are constrained to consider only some kinds of hypotheses or at least to give them priority over others' (1990:58). Especially, the observations of children who are trying to grasp the concepts encoded in language may be accounted for in this way. Constraints in this context should not be regarded as a negative notion, they are a helpful with regard to the "central issue of learning"; given 'the indefinitely large number of generalisations that can be induced from any pattern inputs', 'constraints on the classes of representation that are generated' help us to understand how learning works (Keil 1990:166) (see 2.4).

### 2.3 Individual variation - cognition and development

Kiparsky and Menn (1977) are often regarded as having related the aspect of individual variation in language development/output with cognitive development. Their study, however, is preceded by Nelson (1973), which is concerned with the acquisition and use of words before grammatical constructions are used, and also with the environment and context of the child's development (1973:2, 6). In Nelson's (1973) account, the child is considered to be a problem solver (1973:2), similar to Kiparsky and Menn (1977). Non-linguistic cognitive systems are regarded as being important to the child when he is faced with the task of language learning. For instance, the learning of first words is analysed on basis of the early vocabularies of 18 subjects (between 0;10-1;3 at the beginning of the longitudinal study) (Nelson 1973:6-7). The findings, developmental aspects affecting individual variation, relate to the child's individual selection of words, his (action-based) organisation of themes that guide his vocabulary building and are based on his understanding of the world, amongst other things (1973:34).

Nelson (1973) presents a clear and comprehensive account of the assumptions underlying her study, which is psychological and developmental in nature, concerning cognitive development in relation to language learning. An outline of this account is presented below (1973:2,3):

- i) *basic continuity* - continuity both in developmental processes and structures as the same types of structures and processes are used throughout development. Changes in these are gradual and continuous. This implies the assumption that "'preverbal" development is integrally related to later development' (1973:2).
- ii) *active processor of the environment* - the child is regarded as encoding sets of features of the perceived world. The definition of features outside the context of their use is rejected, 'inasmuch as what is a feature or an element in one context may be a chunk or a construction in the other' (1973:2). Moreover, '[c]hildren cannot be expected to encode the same or the same number of features that adults do in the same situation because the total context of perception, including past experience, is different in them' (1973:2-3).
- iii) *organisation of the world* - information about the world is organised and encoded by the child, resulting in perceptual-cognitive constructions (schemata, concepts). Information that is not entered in such a construction is not encoded or ultimately lost.



- iv) *expectations of the world* - the child has expectations about the world, based on his perceptual-cognitive constructions and these expectations are accommodated in a hypothetical model of the world which is constantly tested and adapted. This model is the basis of his actions. His view on the world is becoming more like the social and physical world around him through strategies of information processing and hypothesis testing.
- v) *interrelation of cognitive functions* - the cognitive functions that the child develops and that make up his construction of the world are interrelated, e.g. language is necessarily related to the understanding of physical relationships and the system of social relationships. The pre-language constructs of the child are a necessary basis for language acquisition.

#### 2.4. Representational redescription

Karmiloff-Smith (1993) argues that 'developmental change, including linguistic change, can only be understood fully in terms of an epistemology that integrates both innate constraints and constructivism' (1993:563) (see 1.). On the one hand, Piaget's views are endorsed in as far as they advocate an epigenetic constructivist view of biology and knowledge, and a vision of the "cogniser" as an active participant of his own (cognitive) ontogenesis. On the other hand, the view on the neonate human mind is adopted that *some* aspects of human knowledge are innately specified (1993:564). Some structures are believed to be domain-specific from early infancy and constrain subsequent learning in the interaction with the environment (1993:585). These dispositions are regarded as 'special attention biases [that] channel the way in which the child processes constrained classes of inputs that are ... relevant [numerically, linguistically, physically, in relation to cause-effect relations, etc.]' (1993:564). So, development 'involves both some innately specified information *and* subsequent learning, and in both cases the infant is highly dependent on information from the environment which affects brain structure' (1993:366).

With regard to innate constraints and developmental change, Karmiloff-Smith (1993) proposes that the initial, special-purpose structures are represented as *procedures* that are activated in response to external stimuli. These procedures are not accessible as knowledge. Only through representational redescription, certain aspects of knowledge can become accessible to other parts of the brain. '[H]uman development crucially involves the passage from representations that constitute knowledge *in* the mind to representations that acquire the status of knowledge *to* other

parts of the mind' (1993:567). These representations are then considered as units in their own right (Karmiloff-Smith 1979:91). With development progressing and in interaction with the constraints of the environment, the organism recreates its basic organisation (Karmiloff-Smith 1993:567).

In redescribing representations, the lower levels are left intact and copies of these are redescribed. This redescription involves a loss of information at the higher level. However, this information continues to exist at the lower level (1993:569). Redescription gives rise to 'the existence in the mind of multiple representations of similar knowledge at different levels of detail and explicitness' (1993:573). So, through representational redescription and restructuring of already stored knowledge, knowledge is gained. The process of representational redescription is posited to take place repeatedly throughout development. In other words, 'each level or redescription is not linked to a *stage* of development, but is part of reiterated *phases* of development within each cognitive domain' (1993:570).

Representation at the initial level is in the form of procedures (see above). These procedures respond to and analyse external stimuli (1993:570). In the proposed model, a subsequent, reiterative process applies, i.e. an abstraction in a higher level language (representational redescription), and the information at the higher level is open to inter- and intra-domain representational links. At the first higher level, this knowledge is available to other parts of the system. Conscious access requires further redescription and gives also rise to the loss of some of the details of procedurally-encoded information. Karmiloff-Smith (1993:571), after Mandler (1992), presents the following illustration:

Consider ... the details of the grated image delivered to the perceptual system when you see a zebra. A redescription of this into "striped animal" (either linguistic or image-like) has lost many of the perceptual details. To Mandler's example, I would like to add that the redescription allows the *cognitive* system to understand the analogy between the animal, zebra and, for instance, the (British) road sign for a zebra crossing (wide white and black regular stripes), even though these stimuli deliver very different [details] to the *perceptual* system. A species without such representational redescription would not find the zebra and the zebra crossing sign analogous. The redescribed representation is, on the one hand, less special-purpose and less detailed but, on the other, more cognitively flexible because transportable to other goals and making possible inter-representational links. Unlike perceptual representations, conceptual redescrptions are productive; they make possible the invention of new terms (e.g. "zebrin", the antibody which stains certain classes of cells in striped patterns).

Representational redescription thus changes procedurally-encoded representations into explicit redescription. Whenever a component of the child's cognitive system has reached a "stable state"



or behavioural mastery, information is extracted which can be used more flexibly for other purposes. The system internal stability is the basis for change, namely representational redescription, to result in cognitive flexibility and consciousness (Karmiloff-Smith 1993:571-72). This type of change, in addition to change that originates in cognitive conflict, e.g. mismatch between input and output in language, is responsible for human cognitive change, and is regarded as the product of 'system internal dynamics' (1993:572) not necessarily requiring external pressure.

Regarding language acquisition, it is suggested that: i) infants compute a constrained class of specific linguistically inputs, making a distinction between linguistically relevant and non-linguistic sounds; and ii) there is a large bulk of linguistically relevant representations in the infant's mind at the time language production starts (1993:575). Language acquisition is regarded as 'a set of constraining biases for attending to linguistically relevant input and subsequently, with maturation, a number of parameters to be set via some inductive mechanism' (1993:575) as far as the initial mapping operation is concerned. In addition, *external* reality serves as the input to form initial representations; and the *internal* representations are the basis for the child's mini-theories about the linguistic system and the subsequent redescription of procedurally-embedded knowledge so as to attain a flexible and creative use of language and the capacity for metalinguistic reflection (1993:577). After a child has become aware of certain distinctions, he will "work" at them in order to master these distinctions by opposing them by means of linguistically or otherwise represented external markers that are later integrated in a more abstract system (Karmiloff-Smith 1979:114-15) (see 4.3).

## 2.5 Perceptual analysis

A notion related to representational redescription is *perceptual analysis*. Mandler (1992) introduces perceptual analysis as the mechanism by means of which perceptual information is analysed, and new information is abstracted, i.e. information in a non-perceptual sense (1992:589), resulting in concepts. It 'involves the active recoding of a subset of incoming perceptual information into meanings that form the basis of accessible concepts' (1992:589). In fact, perceptual analysis is comparable to representational redescription or 'redescription of procedural knowledge' as discussed by Karmiloff-Smith. It is regarded as 'a simpler kind of redescription' (1992:589). Namely, whereas perceptual analysis is defined as being often

concurrent with perception, the recoding into a different format in representational redescription is discussed as an off-line process, redescribing already established representations. Both notions are concerned with the mechanism of the change from perceptual information to knowledge available to the child. In particular, Mandler (1992:587) proposes

that perceptual analysis results in redescrptions of spatial structure in the form of image-schemas. These redescrptions constitute the meanings that infants use to create concepts of objects, such as animate and inanimate things, and relational concepts, such as containment and support. I further propose that image-schemas provide a level of representation intermediate between perception and language that facilitates the process of language acquisition.

These preverbal concepts at this intermediate level are assumed to be global in nature, i.e. shallowly analysed.

Perceptual analysis involves a redescription of spatial structure and of the structure of motion that is abstracted primarily from vision, touch, and one own's movements. In this view, perceptual analysis involves recoding schematic reconceptualizations of space into schematic conceptualizations of space. They are abstracted from the same type of information used to perceive, but they eliminate most details of the spatial array that are processed during ordinary perception (1992:591).

Languages vary as to where they make [categorical distinctions], and these the child must learn from listening to the language. But the hypothesis [Mandler is] operating under is that however [these] cuts are made, they will be interpreted within the framework of the underlying meanings represented by nonverbal image-schemas. That is, some of the work required to map spatial knowledge onto language has already been accomplished by the time language acquisition begins. Children do not have to consider countless variations in meaning suggested by the infinite variety of perceptual displays with which they are confronted: meaningful partitions have already been made (1992:598-99).

## 2.6. Conclusion

The discussion in 2.1-5 presents a picture of the child and his (language) acquisition process that looks as follows: the child is actively involved in his learning process. His perceptual abilities enable him to observe the world around him, resulting in a model or concepts of the world that are constantly tested and adapted by the child. The child's observations are assumed to be innately guided by constraints or developmental cognitive focuses or attention biases. These channel the child's attention with regard to the type of external phenomena during a particular developmental period (giving rise to similarities in acquisition across languages). Within these cognitive constraints, the child follows his own route towards the linguistic representation that reflects the language of his speech community (individual variation).

Concerning the child's observations of the world around him, the child is assumed to have the innate ability to encode this perceptual information into a mental representation. Perceptual

analysis and representational redescription abstract information from his perceptual and/or more concrete established representation, to result in a non-perceptual, higher-level representation. The resulting representation is regarded as cognitively more flexible. Representational redescription applies reiteratively, incorporates new information and also generates more abstract representations.

This global account of the child's (language) process makes it clear how the external information that the child perceives is assumed to become internalised as a mental representation. It points to a cognitive-based constructivist approach to acquisition with innate attention-biases (see 1.2).

Most studies in the area of cognitive development and language (discussed here) are aimed at the semantic and, to a lesser extent, the syntactic aspect of language acquisition (e.g. Karmiloff-Smith (1985, 1992, 1993), Bowerman (1993), Nelson (1973, 1986), Cromer (1991), Keil (1990), Mandler (1992)).

When studying early phonological acquisition, the question arises whether the findings in other cognitive domains can be related or can be assumed to have a parallel in the phonological development of a child. Can the findings concerning acquisition strategies in one domain be extended to another? Naturally, this question does not refer to a straightforward extension or adoption of findings regarding language development from one domain to another as the object of learning in different linguistic components is essentially different. However, is the grouping of certain objects as perceived by the child according to shape or meaning comparable to grouping of speech sounds? Is the role of perceptual information and analysis inherently different for sound? The question of cross-domain extension of cognitive findings relates to the acquisition mechanisms that are assumed on the basis of observations. Are these mechanisms intrinsically domain-bound, and thus refute the use and/or admissibility of a cross-domain view on cognitive development as reaction to findings in a particular domain?

An extreme application of cross-domain extension is provided by the view that sensori-motor activity alone can account for language acquisition (without the invocation of domain specificity, see Karmiloff-Smith 1992). This is illustrated by the Piagetian-based view that syntax is derived from exploratory problem solving with toys, that the lining up of objects forms the basis for word

order, and that trying to fit one toy inside another has a direct relation with embedded clauses (Karmiloff-Smith 1992:11). The acquisition of syntactical aspects is thus regarded on a par with sensori-motor development.

In 3., the questions raised above will be considered in the context of semantics and phonology, and early language acquisition.

### 3. Cross-domain extension<sup>1</sup>

Here, cross-domain extension, raised in 2.6, is regarded from a linguistic perspective that is restricted to the semantic and phonological domain, which are both relevant at the onset of speech, and to the period of early language acquisition. Below the relation between the development of early word meaning and form is discussed on basis of the semantic relations discussed in Lyons (1977) and the triad scenario in Gilles and de Schutter (1987).

The aim of the discussion here is three-fold. It considers the question whether it is warranted to assume a parallel development in the semantic and phonological domain with regard to the early acquisition period. This relates to the cross-domain extension aspect mentioned above. Also, the origin of the child's phonological system is discussed. It appears to have its source in the child's early triad script (3.1). This leads to a more general issue, namely the development of the child's understanding of the world around him in terms of event representations, and related phenomena such as the formation of categories and the relevant phonological acquisition structure (3.2).

#### 3.1 **Differentiation of relation systems**

##### 3.1.1 *Semantic relations; reference, denotation and sense*

In semantic theory, the notion of *reference* is essential. It is the means by which 'items in the vocabularies of all languages can be put into correspondence with "features" of the physical world' (Lyons 1968:425). Two related and less concrete notions are *denotation* and *sense*. These three semantic relations are defined below following Lyons (1977).

Reference 'is an utterance-bound relation and does not hold of lexemes as such, but of expressions in context' (Lyons 1977:208). The class of physical world objects, properties, activities, processes, events etc. to which an expression applies is the denotatum of a particular reference (1977:207). Denotation 'is a relation that applies in the first instance to lexemes and holds independently of particular occasions of utterance' (1977:208). Sense refers to the relationship that holds 'between the words or expressions of a single language independently of the relationship, if any, which holds between those words or expressions and their referents or denotata' (1977:206). So, with regard to degree of abstractness, the relation of reference is least

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<sup>1</sup> Consideration of the aspect of cross-domain extension has arisen from a discussion with Morag Donaldson on cognitive development.

abstract, and that of sense is most abstract as it is applied to lexemes without reference to the physical word nor to the denotata of that lexeme.

Language acquisition can be regarded as classifying the world according to these three semantic relations. Lyons discusses this development, or ‘the ontogenesis of reference and denotation’ on basis of the four phases proposed by Quine (1960), which are given below (Lyons 1977:226).

- (1) i) all names are used to name unique denotata.
- ii) the child acquires the distinction between proper names and words with multiple denotations.
- iii) the child learns how to construct and use such collocations as *tall man* and *blue book*.
- iv) the child masters the use of collocations like *taller than Daddy*.

Initially, the child will interpret and use nouns in a similar way as proper names, and there is no use for the distinction between reference and denotation. Later these two types of relations are differentiated. With regard to the two more abstract semantic relations, ‘the sense and denotation of semantically related lexemes is learned, more or less simultaneously and presumably by process of gradual refinement (involving both specialization and generalization), during the child’s acquisition of a language-system’ (1977:228). The meaning of a word in the different systems of relations (denotation, reference and sense) is discovered, namely, a particular word and its denotata, this word and its meaning in a specific context, and this word in relation to the other words in the language.

So, schematically the initial development of the semantic component can be presented in (2), where in later stages the three semantic relations are differentiated, and the abstract representation of sense is gradually expanded.

(2)    *concrete level*

denotation = reference

following stage:

reference
denotation
sense

*cognitive level*

### 3.1.2 *Phonological development*

The phonetic part of a child's script can be regarded as relating to a specific situation. A script is a holistic structure with which is associated a phonetically consistent form (PCF), i.e. a protophonemic structure that is regarded as more stable than the child's structure in babbling (Gilles and de Schutter 1986:127). The elements of this holistic structure basically are an action, an object and a PCF, the utterance of which is part of the execution of the script (1986:132-33) (see also 3.2.1). This triad can thus be considered as the child's pre-semantic system as well as his pre-phonological system. The child's PCF is context-bound; sound is related to a specific action and object by the child, and as such has meaning. This shows a resemblance with the semantic stage of development when reference and denotation coincide in the child's use of words (see (2) in 3.1.1). Initially, a specific script consists of a specific sound, in the form of a holistic sequence, and a specific action and object. Later, the members of the script are decontextualised semantically and phonetically. Concerning the latter, sounds are considered as individual entities (rather than part of fixed sequences), and their contrastive role in the sound system of the language, i.e. relations to other sounds, is gradually discovered. The child also learns to match different realisations/instances of a sound to one phoneme. The distinction between a holistic sound pattern and the occurrence of a sound as a phoneme in different words that are acquired by the child is comparable to the development of the semantic system of relations in later stages, when the interrelationship between the denotation of a word and its context-bound reference becomes part of the child's understanding.

Considering the relations of reference, denotation and sense with reference to early phonological acquisition, the following development can be assumed. The gradual discovery of the different phonemes by the child and their interrelations can be considered as the establishment of the denotation relation between the sounds of a language. How these sounds are realised in a particular environment, i.e. context-bound, is expressed by means of reference. The entities in the reference system of sound are phones. The denotata in this case are phonemes which are also concrete entities. Initially, the child does not differentiate between phones and phonemes, as reference and denotation coincide in the child's script; sound only has meaning in a specific context, i.e. action and object. On a more abstract level, the underlying representation of the phonemic system is expressed. The sense relation that holds between the different phonemes is



expressed independently of the context in which they occur; it applies to the interrelations between the different elements of the phonological system only.

### 3.1.3 Conclusion

From the discussion in 3.1.1 and 3.1.2, it becomes clear that the early stages of phonological and semantic development have the following in common:

- a) different kinds of relations are established between the entities in the domain on basis of perceptual information.

*(reference, denotation and sense; and phonetic, phonemic and phonological systems)*

- b) these relations show a similar, cross-domain differentiation.

*(context-bound, context-free and system-internal)*

- c) the acquisition or differentiation of these relations proceeds according to a comparable pattern.

*(denotation = reference → denotation, reference, sense)*

These three aspects, characteristic of the early acquisition period in both the phonological and semantic component, establish the basic notions in these domains. The origin of these three relation systems, constituting the two domains, is in the child's script and the entities therein: PCF, object and action.

## 3.2 Category formation

The mechanism through which categories are formed also appears to be related to and be essential for the early development of the child's cognitive/linguistic structure in both the phonological and semantic component (see 3.1.3). In order to discuss this development, the script proposal in Gilles and de Schutter (1986) is discussed in more detail (3.2.1), as well as event representation in later stages of development (Nelson 1986) (3.2.2).

### 3.2.1 Early stages: scripts

A script can be regarded as a holistic structure with semantic and phonological content (see also 3.1.2). The basic elements of a script that are essential for establishing the semantic relations are an object, an action and an utterance. This utterance or PCF (phonetically consistent form) can also be accompanied by an action or gesture alone, for instance, waving bye-bye. PCF's are the child's equivalent of words and are produced in the context of highly specific events or objects (Gilles and de Schutter 1986:131).



Inkeeping [*sic*] with a contextualized view of cognitive representation ... we hypothesize that if the context in which the child experiences an object is an event in which persons do certain thing with objects, vocalize, and so on, the representation of that event is the conceptual context in which the conceptual representation of that object is embedded [i.e. a script]. ... The execution of the script is determined by the presence in the situation of one (or more) element of the script, in other words, the instantiation of one of its slots (1986:132).

The further development of a script is characterised by a decontextualised use of the child's PCF's, i.e. 'the gradually freeing up of the situation in which the PCF is used from the one described by the script' that acts as a kind of prototype (1986:132). This decontextualisation is discussed in terms of *generalisation* and *defunctionalisation* (1986:130).

Defunctionalisation is described as the process through which 'uttering the PCF becomes more and more independent of the performance of the action to which it was initially strictly bound' (1986:130). This is an important development with regard to the acquisition of linguistic reference 'in that the child now becomes able to utter a PCF outside the context of this actual manipulation of an object' (1986:134). So, the nature of the PCF changes from being "action-and-object specific" to being "object specific" (1986:134-35). This has consequences for the situation in which a child will produce a PCF;

Although an object, or better, the representation of the object, may be part of a script, the allocation of the objectconcept [*sic*] does not necessarily imply the execution of the procedural knowledge associated with it. In other words, there occurs a division of the originally wholistic [*sic*] scripts, which takes the form of a separation of the *action-component* and the *object-component* of the script (1986:135).

The other developmental process related to a script scenario is generalisation; 'after an initial stage of stringent event-bound usage, the boundaries of the event in which the PCF occurred are transcended' (1986:130).<sup>2</sup> This process can occur spontaneously and is then assumed to mainly proceed along two dimensions (1986:133): i) perceptual similarity - similarity of one or more features of an element in the situation and an element in the script, and ii) equifunctionality - the PCF is used for things the child can do the same thing with. These aspects will be further discussed below (3.2.5).

<sup>2</sup> Generalisation can also occur on basis of an adult model, namely when an adult performs the script-specific action and utters the PCF, but uses a different object from the script-specific object, or when the adult will do this without uttering the PCF. For an illustration of this, see Gilles and de Schutter (1987:133).

In the transitional phase, the PCF of a child is claimed to illustrate the confluence of two hypotheses, namely the hypothesis that 'a segmental soundpattern can serve the indicative function', i.e. a pragmatic prerequisite or condition for linguistic reference (1986:127-28). The second hypothesis is semantic in nature; 'other soundpatterns can relate globally to sets of objects or events which are linked together in terms of experienced commonalities' (1986:128 after Dore, Franklin, Miller and Ramer 1976).

### 3.2.2 *Later stages: event representations*

Nelson (1986) presents the discussion of various studies that are part of a collaborative research program that aimed 'to identify the basis for children's cognitive competence in everyday life' (1986:x).<sup>3</sup> The ground plan of this program was that the basic form of the child's knowledge of the world around him is constituted by representations of events. The work was undertaken from 'the premise that event schemas are the initial form by which children represent experience to themselves, and that more abstract structures may be derived from these schemas over time and with development' (1986:x).

Event representations are thus clearly related to the script scenario proposed in Gilles and de Schutter (1986) (see 3.2.1), and also to the representational redescription model discussed in Karmiloff-Smith (1992, 1993) (2.4). The way in which these proposals interrelate will be discussed in more detail below (3.2.4). The discussion of scripts is used to describe and formalise the very early stages of language acquisition (the subject in Gilles and de Schutter is 0:11.15 at the onset of the study), whereas event representations mainly focus on the real world experience of older children that are as eloquent as to give their own verbal interpretation of particular events (Nelson 1986). Here, for the sake of discussion, it is assumed that scripts are the predecessors of event representations, namely that the former relate to the early stage of first holistic word structures, the latter to later stages when relations of reference, sense and denotation are differentiated. At this point, no claims are made concerning the theoretical compatibility of these two representational means.

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<sup>3</sup> In the discussion of this book, no distinction will be made between the different authors of separate chapters in the book. All references will be to Nelson (1986).

Rather than discussing the child's knowledge of objects and their relations, and on cognitive processes that operate on 'representations of states and relations in the world' (1986:273), Nelson (1986) focuses on events and event knowledge (see above).

The research reported ... indicates that even very young children represent events as complex and dynamic, that is, as holistic structures involving internal change over time. ... [we suggest that] events, incorporating changes of state, are the initial content of mental representations, and that stable mental elements (e.g., concepts, categories) are derived from them (1986:3).

The means by which these "events" are presented in the event representation research discussed in Nelson (1986) are basically *scripts* (see also below). A script is defined as 'an ordered sequence of actions appropriate to a particular spatial-temporal context and organized around a goal' (1986:13 after Schank and Abelson 1977). A script is made up of slots with a default value, which 'is assumed if the person, object, or action is not specified when the script is instantiated in a particular context' (1986:13). There are requirements concerning the contents of the slot. The slot fillers are regarded as being an important aspect for the semantic development of the child (see 3.2.3). Scripts are the structure which enables that development, namely, it is assumed that children "impose" event representation structure on their perception of the real world (1986:6-7). These event representations reflect 'the structure and variability of our experiences with real world events', and thus 'provide the basis for inferential or constructive processing' (1986:49) (see 3.2.3).

With regard to the contents of the slots in an event representation, the development is assumed to be from restricted to less restricted, and the range of possible slot fillers is expanded. For a discussion of the principles governing the selection of appropriate slot fillers, again, see 3.2.3. Here, the process underlying the expansion is discussed.

Initially, all slots of an event representation are occupied by a unique (cf. triad scenario) or very limited range of slot fillers. Gradually this range is expanded, and the restrictions on the slot fillers relax as the child learns more about the world around him. The possible candidates that can occupy a slot are learned by the child within the context of an event representation. Gradually, the child discovers how to use slot fillers in other contexts too, which restrictions on their use are no longer valid, and how to regroup them 'into hierarchical relationships on the basis of similarity, class membership, and logical differentiation' (1986:191). Thus, event representation and the slot fillers used can be regarded as an indication of the child's acquired knowledge of the world, and

the range of slot fillers as a reflection of his understanding of semantic entities (e.g. objects, relations, situations) in different contexts (1986:49).

Younger children are more constrained by the organization of event knowledge and are apparently less flexible than older children in performing tasks that depart too much from that structure (1986:68).

The familiarity of a child with an event, which is basically the extent to which the child has expanded his event representation, is relevant for his cognitive development according to Nelson (1986). It is assumed that a more advanced understanding or cognitive organisation of event representations is not so much related to changes in the basic structure of the representation. Rather, this has to do with 'the degree to which it is qualified or elaborated upon, and [such changes, advancing the cognitive organisation of a child,] appear to result as much from amount and type of experience with the event as from age-related changes in development' (1986:68).

Considering the scripts a child has in the course of his cognitive development, different sorts of scripts are distinguished. The classification of scripts is as follows (Nelson 1986:14 following Abelson 1981): *weak scripts* specify the components, *strong scripts* specify the components and the order in which they occur. A generalised event representation has a strong temporally invariant structure, and can thus be regarded as a highly scripted event. In terms of Nelson (1986), the triad scenario, discussed in Gilles and de Schutter (1986), is a weak script, which can develop into a script with more elaborate specifications. As becomes clear from the passage below, this type of script serves the further development of the child's cognitive abilities at different stages in different ways:

... organized event knowledge, particularly when logically organized, may constitute the basis for much of the later abstraction and decontextualization of knowledge. The move from simple to more complex scripts may reflect a growing awareness of event categories and provide the basis for the representation of both syntagmatic and paradigmatic relations at a more abstract level ... The theoretical significance of these findings is their suggestion that structured event knowledge may constitute the source of such higher-level cognitive operations as taxonomic organization and causal inference (Nelson 1986:69).

### 3.2.3 *Slot fillers and grouping principles*

Event representations are based on concrete, perceptual experience and provide a system of information, the nature of which makes it suitable as input to cognitive processes, as 'processes such as categorization, pattern analysis, inference, and so on, operate not on real world phenomena but only on the mental representation of those phenomena' (Nelson 1986:7). In Nelson

(1986), concerning the nature of representation, the sequence is regarded as follows: 'a conceptual system of event representations is subjected to cognitive analysis and ... a more abstract system of knowledge organization, a semantic system, is derived or constructed from this analysis' (1986:196).<sup>4</sup>

The analysis comprises processes such as pattern analysis, categorisation of similar elements (with similarity defined along several different dimensions), correlation of co-occurring elements, linear ordering (i.e. sequencing), organisation into higher-level units (i.e. categorising), and inferencing (i.e. filling in informational gaps on the basis of prior knowledge) (1986:10). These processes are primarily concerned with the contents of the slots of the event representations. (See 3.2.2 for a discussion on the process of expansion of slot fillers.) Through the application of these cognitive processes, the nature of the slot fillers changes from more concrete to more abstract. From the slot filler categories a more abstract taxonomic network of semantic relations develops, including, for instance, class inclusion, part-whole relations, etc. (1986:202). Event representation can thus be regarded as the onset towards an abstract representational structure (1986:11).

The criteria for the slot fillers as such are grouping principles, such as contiguity, similarity and substitutability (1986:245), which could be regarded as more concrete and direct relations than class inclusion and part-whole relations (see above). The basis for the formation of categories in different slots of an event representation is shared function or paradigmatic relation (i.e. the relations between elements of the same type occurring in similar contexts in different structures) (1986:192).

Substitutability among category members is essentially the paradigmatic relation found in the analysis of linguistic structures. It contrasts with contiguity of members known as the syntagmatic relation between unlike elements in a structure ... . Members that are substituted for each other in a script structure ... need not have a basis in similarity; rather they fit into functional slots in an event structure' (1986:245).

The slot filler principles are thought to be closer to the semantic organisation of pre-school children than broad taxonomic categories (1986:194). The most significant aspect of the slot filler

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<sup>4</sup> Cf. Mandler's (1992) perceptual analysis and Karmiloff-Smith's (1993) representational redescription in I2.4 and I2.5, respectively.

model, in as far as the discussion here is concerned, is that it 'suggests a basis for categorial evolution' (1986:193).

#### 3.2.4 *Summary*

The source of both the phonological and the semantic development of the child is assumed to be in a holistic structure, a script, which comprises semantic and phonological content. A particular object, action and utterance (phonetically consistent form) represent the child's experience of a particular situation. This triad scenario is triggered whenever one of the three elements is executed or present (Gilles and de Schutter 1986). Later, the use of the members of the triad is decontextualised, and the restrictions on the occurrence of triad components gradually become less context-bound. The protostructure remains intact, while its slots can be filled with a wider range of, for instance, objects, actions, etc. The aspect that characterises the generalisation of the members of a triad are perceptual similarity and equifunctionality. Also, a triad scenario typically does not specify an order of occurrence for the components. This is comparable to a weak script in terms of Nelson (1986).

In later stages of the process of the child's representation of the world around him, his knowledge can be assumed to be represented in the form of event representations (Nelson 1986). Event representations specify an ordered sequence of actions with different slots that can be filled by specified roles, objects and actions, and for which there are requirements as to what can fill a specific slot. The event representation functions similarly to the triad structure; its different slots are occupied with a growing range of slot fillers as the child's knowledge of particular contexts grows and the restrictions on the occurrence of slot fillers are relaxed. The event representation can be regarded as the basic structure, as it enables the child to group the object, events, relations, etc. that he perceives in the world in the different slots. Cognitive processes (e.g. categorisation, sequencing, pattern analysis, inferencing) subsequently apply to these slot fillers, resulting in more abstract knowledge. The grouping principles governing the expansion of the range of slot fillers for a particular slot in an event representation are substitutability (cf. equifunctionality), similarity (cf. perceptual similarity) and contiguity. This expansion takes place at a perceptual/conceptual level that is directly derived from the child's observations of the world around him. Thus,

a continuum [is assumed] from immediate [perception] to abstract representational structures of varying types, subject to cognitive analysis and transformation through a set of operations that take place at a cryptic [i.e. inaccessible to conscious awareness]



(1986:9)] level of cognition. Development of the system is conceived to be the result of changes produced by these operations, driven by but not fully determined by new input (1986:11).

The development of this sequence, as discussed in Nelson (1986), from experience to perceptual representation to abstract representation is comparable to the effect of the representational redescription process in Karmiloff-Smith (1993). Both proposals include a “transformation” (Nelson 1986:11) that mediates between less abstract and more abstract information. It appears that the cognitive processes mentioned in Nelson (1986) can be regarded as being instances of representational redescription. In that respect, Nelson (1986) is a less theoretical, more specific discussion of cognitive development, which focuses on the semantic domain.

### 3.2.5 *Phonological protostructure and category formation*

From the object and action components of the holistic triad (3.1.2), semantic development progresses towards a more elaborate and context-free system of abstract, semantic relations. The phonological contents of the triad script, the acoustic member, is also decontextualised, as well as analysed phonologically. This decontextualisation entails a differentiation of denotation and reference relations in the phonological domain. The discussion here does not relate to the development of the different relation systems. It focuses on the mechanism of category formation in phonological structure, and makes reference to the notions discussed in relation to the nature and development of event representations (3.2.2-4).

The first utterances or words of the child are assumed to be holistic in nature. The combination of sounds is “fixed” and anchored in a particular structure. Later, when the child’s abilities are sufficiently developed, the child is no longer bound to that particular sound structure, as he has mastered the sounds individually. The overall structure of his word, however, remains a prominent feature in his vocabulary, as illustrated by wordpattern observations (see 5.2). A wordpattern is defined as a recurrent structure in the child’s output with a particular syllable shape and a particular configuration of sounds (see 5.).

It appears that the child maintains the syllable structure, while expanding the range of slot fillers, i.e. sounds. It is obvious that, comparable to the event representation structure, the wordpattern can be regarded as the protostructure of the child’s phonological development. The slot fillers in this context are the different sounds for which the child has developed “phonological awareness” (Ferguson and Farwell 1975). The significance of the wordpattern in the child’s output gradually

has changed; from illustrating the context-bound nature of his output in sound as well as structure to providing a basic structure that enables the child to classify perceptual information and represent it in such a form that it can easily be redescribed. As protostructure, the syllable structure skeleton provides the tool for the child to discover the functional nature of sounds. When the child discovers what slots in the protostructure a sound can occupy, he acquires information about its identity (for example, vowel v. consonant, its ranking in the sonority hierarchy, place characteristics, etc.). As the range of slot fillers expands, the child collects information on segment classification that is the basis for his phonological system (i.e. sense relations) (see 4.3). This process is primarily concerned with equifunctionality, and therefore with the principle of substitutability.

The two other grouping principles discussed in Nelson (1986:245) (see 3.2.3) are contiguity and similarity. Similarity can be regarded as the main principle with regard to the acoustic nature of sounds and the formation of (acoustic) natural classes. Contiguity expresses the observation that the child is aware of the differentiation of the various slots in the protostructure in terms of functionality, or 'the syntagmatic relation between unlike elements in a structure' (Nelson 1986:245). It contrasts with the substitutability of different slot filler category members, i.e. the paradigmatic relationship. In this way, contiguity and substitutability operate as two different axes, placed square to one another. The third "slot filling" principle, similarity, operates within the space of the paradigmatic axis, providing a parameter for intersegmental substitutability of sounds, different from the intrasegmental substitutability expressed on the whole of the paradigmatic axis.

In short, substitutability is concerned with functionally similar sounds, contiguity with functionally different sounds and similarity with acoustically similar sounds. These three grouping principles characterise the process of expansion of the slot fillers in the protostructure, i.e. the different sounds that can function in the segmental slots of the wordpattern once decontextualised and no longer bound to a particular configuration of sounds. The protostructure provides a basic structure for the child as he gradually develops his phonological awareness and it enables him to classify perceptual information in a constructive, i.e. functionally relevant, way. The perceptual information contained in the protostructure representation could be envisaged as the input to cognitive processes or, in terms of Karmiloff-Smith (1993), representational redescription, to



result in a more abstract representation of the child's phonological awareness, i.e. his phonological system. For a discussion of this aspect, see 4.3.

The validity of extending this mechanism to the phonological domain is confirmed in Karmiloff-Smith (1992:167):

The *function* and *process* of representational redescription are ... domain general in that an equivalent process operates in the same way in different domains and microdomains. But representational redescription recurs at different times throughout development. Although the process is domain general, the structure of the changes over which representational redescription operates is constrained domain specifically. In other words, it is affected by the form and the level of explicitness of the representations supporting particular microdomains at a given time (1992:167).

On basis of the above discussion (3.2.1-4) and the nature of the process of category formation within the phonological domain (3.2.5), it is concluded that the mechanism of category formation in the phonological and the semantic domain are comparable in that similar processes are responsible for the formation of categories, i.e. grouping principles. In this way, the grouping principles can be considered as more concrete, perceptual processes (which are mainly active before redescription into more abstract representation, for instance, by means of cognitive processes, 3.2.4). In both domains, the role of protostructure, the slots of which are filled according to grouping principles, is significant as it provides a structural tool for category formation.

### 3.3 Conclusion

The discussion of the early development in the semantic and phonological domain has illustrated that there are similarities in the nature of these developments and the mechanisms employed. The differentiation of relation systems in the child's semantic system appears to have a parallel in the phonological domain (denotation=reference → denotation, reference, sense). Also, the kind of relations that form the essence of these two domains show a close similarity. Moreover, following the account of the early triad scenario as proposed in Gilles and de Schutter (1986), the child's semantic and phonological system appear to originate in the same structure, namely the child's holistic structure comprising an utterance (PCF), and object and an action. On the basis of these aspects, it can be concluded that the parallels in the early cognitive development of phonological and semantic structure are significant (3.1).

The similarities between the acquisition processes in the different domains (see above) relate to general processes and relations rather than to the character of, for instance, the entities between which relations such as sense and reference hold. In terms of Karmiloff-Smith (1993, 1992), it concerns domain-general aspects:

Infants and young children are active constructors of their own cognition. This involves both domain-specific and domain-general processes (1992:11),

where *domain* is defined as 'the set of representations sustaining a specific area of knowledge (language, number, physics, and so forth) as well as the various microdomains that they subsume' (1992:165).<sup>5</sup>

The child's early triad scenario develops and is gradually decontextualised. Not only are the triad members used in contexts different from the triad, the use of the triad structure itself is generalised, i.e. its slots can be filled by different elements (3.2.1). In a later stage of the child's development, the triad structure is assumed to be succeeded by event representations that offer a basic structure with different slots for objects, actions, etc., reflecting the child's understanding of the world around him (3.2.2). The range of slot fillers expands, and the grouping principles governing this expansion are similarity, contiguity and substitutability. Also, cognitive processes apply to the event representation, which results in a more abstract representation (3.2.3). (See 3.2.4 for a summary.)

The development assumed for the triad scenario into the event representations seems to apply to the development of the child's (sounds in his) words. Whereas initially the child's word has a fixed structure, later the range of sounds in the slots of this structure expands (cf. wordpattern observations in 5.). Within the context of this phonological protostructure and by applying the basic grouping principles (see above), the child can expand/strengthen the relation systems within the phonological component, both inter- and intra-segmentally (reference and denotation). (For the cognitive mechanism that is assumed to underlie the formation of the relation system of sense, i.e. the child's phonological system, see 4.3.)

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<sup>5</sup> Note that the semantic and phonological component have been regarded as different domains throughout the discussion here, whereas, in terms of Karmiloff-Smith (1992:165) they constitute different microdomains within the language domain.

So, both with regard to the development of relation systems and the development of the triad script into protostructure, the extension of findings concerning cognitive development from the semantic to the phonological domain seems to be warranted and even constructive. The extension of these processes to other (linguistic) domains raises relevant questions; and the discussion here illustrates that it is useful to consider domain-general mechanisms of development in a wider, cross-domain perspective.

## 4. Processing model and phonological processes

### 4.1 **Simplification processes**

Phonological processes are originally proposed in Stampe (1979) as part of natural phonology (see below). Although applied differently from their original natural phonology identity, they have been adopted in other proposals in some form or another, mainly to account for the discrepancy between the (adult) target form and the child realisation (Grunwell 1985, Stoel-Gammon and Dunn 1985, Smith 1973, Spencer 1986, Vihman 1981, amongst others). The interpretation and application of phonological processes is discussed below in the context of different proposals, namely Stampe (1979), Smith (1973), Ingram (1974a, 1986) and Grunwell (1982).

Natural phonology (Stampe 1979) proposes that the phonological organisation of speech is governed by an innate set of universal phonological processes (Grunwell 1982:166). In Stampe (1979), the phonological system is regarded as the residue of an innate system of phonological processes (1979:vii). Namely, at birth, the child('s mind) is not blank as far as his phonological system is concerned; 'in its language-innocent state, the innate phonological system expresses the full system of restrictions of speech: a full set of phonological processes, unlimited and unordered' (1979:ix). Phonological processes are defined as follows:

A phonological process is a mental operation that applies in speech to substitute, for a class of sounds or sound sequences presenting a specific common difficulty to the speech capacity of the individual, an alternative class of sounds identical but lacking the difficult property (1979:1).

A phonological process merges a potential phonological opposition into that member of the opposition which least tries the restrictions of the human speech capacity (1979:vii).

Through their application to the child's lexical representation, these phonological processes determine the child's output. They are revised on the basis of linguistic experience; the innate phonological system is thus adapted to the child's performance in progress. Each time the child acquires a new phonetic opposition, his phonological system is adjusted by means of (partial) suppression of a phonological process, or ordering (1979:x). In the post-babbling period (characterised by identical CV syllable sequences), no phonological processes are suppressed, according to Stampe (1979:ix), and the innate system can be considered to have its fullest effect. On the other hand, the adult phonological system is the residue of the innate system, i.e. what is left after the suppression of many of the phonological processes present at the onset of speech.

Phonological processes are assumed to apply to the child's mental representation. Stampe (1979:xiii) states that 'the child's productions result from the application of the innate phonological system to some sort of phonological representation'. He continues:

Most major works on child language agree that the child has internalized a representation of adult speech which transcends in detail his own reduced productions.

The representation of adult speech that is assumed in Smith (1973) is in terms of adult surface phonemic representation (1973:132). Furthermore, the child is assumed to have a set of realisation rules, i.e. 'hypotheses [he] makes about the language he is learning' (1973:206), which state the regularities between the speech sound the child is exposed to and his own phonemic output (1973:132). These realisation rules apply to the lexical representation, to result in the child's output. The realisation rules and the lexical representation are claimed to be psychologically real to the child, unlike the child's realisations (1973:206-7):

... [the rules and representation] are the only constructs to have any psychological validity for the child. That is, the child has *no* other system of his own, and the realisation rules are accordingly explanatory and not merely predictive.

The realisation rules are the reason that the child has the 'ability to produce sounds and sound sequences identical to those of the adult language ... [and] does in fact not' (1973:149). The reason behind both the large number and the endorsement of the realisation rules is the constraints underlying them which are motivated by the concepts of articulatory simplicity and of the principle of least effort (1973:176, 161-62), namely:

- a) tendency towards vowel and consonant harmony
- b) cluster reduction, leading to a general canonical form CVCV...
- c) systematic simplification of the child's inventory of segments
- d) grammatical simplification of the child's phonological system, having a clear morphophonological or syntactic explanation.

The psychologically real status of the realisation rules in Smith (1973) is considered to be a dubious claim on the basis of the characteristics of the learning process in terms of (generative) rules, according to Grunwell (1982). '[T]he child begins his phonological development with a complex set of pronunciation rules, many more than adults have, and eventually loses these rules' (cf. Stampe 1979); '[t]his does not represent an appropriate or even logical characterisation of development' (Grunwell 1982:142) (see below).

Different from the approach taken in Smith (1973), the representation of adult speech that is assumed in Ingram (1974a) reflects the child's inadequate perception and his organisational principles. This mental representation expresses the basic syllabic and canonical shapes of the adult model. Phonological rules, which 'indicate a systematic relationship between the members of a language's sound system' (1974a:50) operate on this underlying form to result in the child's spoken form. The underlying form is basically the form the child perceives without the "noise", i.e. 'any part of the adult word that is never represented in the child's utterance' (1974a:53). The application of the phonological rule for reduplication, for example, takes the following form (1974a:52, Figure 2; 1974a:54, Figure 8):

(1)	<i>cracker</i>		
	adult pronounced form	[krækɾ]	
	child's perceived form	kXæX	
	child's underlying form	kæS	
	REDUPLICATION	kæ	X = noise for syllable
	child's spoken form	[kækæ]	S = syllable

Ingram (1986) incorporates the phonological processes proposed in natural phonology (Stampe 1979), rather than rules (cf. Ingram 1974a); they are regarded as 'statements about how children simplify adult speech' (Ingram 1986:239). The equation *adult form + phonological processes = child's form* is considered to be inadequate (albeit grudgingly); 'the possibility that children actively operate on adult forms to establish their own phonological representations of these words' is raised (1986:233), and a child representation is proposed in addition. However,

The claim that the child has a system of his or her own is controversial ..., yet it appears to account for some otherwise inexplicable aspects of young children's phonological patterns (1986:233).

Still, the adult representation is the starting point for the child's output. This is illustrated by an example regarding the syllable structure patterns of a child (1;10-1;11) (after Priestly 1977) (see also I5., Figure 1). Five ordered processes are proposed to account for his syllable structure, four of which are given below (Ingram 1986:235):

- i) Change all multisyllabic words into the structure C<sub>1</sub>V<sub>j</sub>VC<sub>2</sub>.
- ii) After cluster reduction, place the initial consonant of the adult word into the C<sub>1</sub> position.
- iii) If the second consonant of the adult word is a sonorant, drop it and place the next consonant into the C<sub>2</sub> position (e.g. *carrot* [kajat]).

- iv) If the second consonant is a sonorant, but there is not a third consonant, place the sonorant into C<sub>2</sub> (e.g. *Brenda* [beʝan]).

Grunwell (1982) considers phonological processes with reference to the clinical application of phonological theory. It is emphasised that phonological processes are proposed in the literature as a framework that is not merely descriptive; they are claimed to have explanatory status and some kind of psychological reality (1982:169).

They are, in fact, just another way of stating the systematic relationships between the target pronunciation and the individual's realisations ... In the clinical context, they present these patterns in a more insightful framework than the rules of Generative Phonology [i.e. those proposed in Smith (1973)], since they imply that the patterns in disordered speech are simpler than those in normal speech and that suppression of these patterns involves an increase in the complexity of the organisation of speech production (Grunwell 1982:191).

However, '[g]iven [their] rather dubious psychological status ..., it is probably unwise to attribute anything other than descriptive value to them' (1982:191).

Grunwell (1982) presents a comprehensive list of phonological processes, indicating their chronological order. A distinction is made between structural simplification, concerning the CV structure of words, and systematic simplification that is concerned with the feature content of segments (2) (1982:183).<sup>1</sup> (Ingram (1986) also presents a list of phonological processes. See also the discussion regarding phonological processes in Berman (1977), Ingram (1974b), Grunwell (1981b), Ferguson, Peizer and Weeks (1973), and Menn (1975).)

(2) <u>structural simplifications</u>	<u>systematic simplifications</u>
reduplication	fronting velars /k g ŋ/ → [t d ŋ]
consonant harmony	stopping fricative, affricate → plosive
cluster reduction obstruent+approximant	gliding /r/ → [w]
final consonant deletion	
cluster reduction /s/+consonant	
weak syllable deletion	

With regard to the motivation of phonological processes, rather than their actual form, the proposals are generally less clear. Smith (1973) discusses the constraints underlying the

<sup>1</sup> Note that this division of phonological processes is in agreement with the two parameters for language proficiency in the acquisition process as discussed in Vihman and Greenlee (1987).



phonological processes that share the same end result, namely articulatory simplicity and the principle of least effort. In Stampe's (1979) view, phonological processes are innately and universally present. According to Leonard, Newhoff and Mesalam (1980:29), '[i]t seems quite possible that simplification processes serve the function of making the child's lexicon more phonologically manageable, thus allowing the child greater opportunity to focus on acquiring ... less familiar linguistic features'. This is echoed in Stoel-Gammon and Dunn (1985): 'phonological strategies allow children to organize and simplify the complex phonological system being acquired' (1985:50). This raises the question how/why the child has a phonological system that apparently is too complex for him (see 4.2). In general, phonological processes are simplification devices that describe how the child's form is derived from the adult structure.

Simplifying a representation into another, less complex representation can be regarded as being a processing strategy, in terms of Nelson (1973). She distinguishes between different kind of strategies, namely processing and acquiring strategies (1973:5). Acquiring strategies add new elements to the original repertoire. Processing strategies match elements to the existing repertoire, and are not regarded as giving an account of language acquisition proper. In this respect, phonological processes do not provide an insight into how new elements are mastered; they merely describe the relation between adult word and child output. They do not provide, or require any understanding of the acquisition process. Indeed, Stoel-Gammon and Dunn (1985:36) put it as follows: '[a]lthough we believe that phonological processes provide a useful framework for describing children's systematic simplifications of the adult phonological system, we do not ascribe to the view that they are psychologically real. ... *phonological processes provide a means for describing, but not explaining*' (emphasis mine).

It can thus be concluded that phonological processes do not provide or contribute to a better understanding of the acquisition process. If anything, they are better regarded as well-formedness conditions (cf. Menn 1978a: 5.1.2). The desirability of these descriptive devices is further discussed in 4.2.

#### 4.2 Perception and production

From the discussion of the proposals that incorporate phonological processes (4.1), it has become clear that the basic assumption of phonological processes is the "availability" to the child of the specification of an adult or adult-like representation. To underlyingly represent a complete



representation of this character, or a more detailed representation than can be observed in the child's production, raises many questions; amongst others, what is the status of the representation?, is it acquired or innately specified?, does it reflect the child's perceptual abilities?, etc. To assume a complete specification at a time when the production of the child is limited requires a closer look at the relationship between perception and production.

The precise degree to which the contrasts mastered by the child in perception and production, respectively, are claimed to differ in a theory of phonological acquisition is probably a matter of opinion. For example, two proposals presenting an extreme view are Smith (1973), assuming a full representation with all adult contrasts underlyingly present, and Waterson (1987), who only posits a child representation reflecting those contrasts that are actually produced by the child. To assume that perception, to a certain extent, precedes production in ((phonologically) non-impaired children) appears uncontroversial. Motor control immaturity and perceptual limitation, amongst others, can presumably be related to the observation that children do not give evidence of knowledge of all adult phonological oppositions in their realisations. Stoel-Gammon and Dunn (1985) state that linguistic, or phonemic, perception, is closely related to the set of words already familiar to the child. Phonemic contrasts are easier to identify for the child in words that are part of the child's receptive vocabulary (1985:57) (see 5.).

The observation that some contrasts are perceived by children at a very early age is often the basis of the claim of good perceptual abilities in babies and young children. However, the argument in favour of "perfect perception", namely that very young infants can distinguish between speech sounds, is not in agreement with the assumption that 'universal sensitivity declines', on the basis that phonemic contrasts that are not part of the language that the child is learning will be lost within the sensitive period, i.e. after one year (Johnson and Karmiloff-Smith (1992:40) (cf. Trehub 1976; Eimas, Miller and Jusczyk 1987; and Hale and Kisko 1997a and references therein).

This also relates to cognitive development in general. Namely, Mandler (1992:587-88) discusses a child's early categories (referred to as perceptual because they are not yet regarded as being representational in nature). They are formed on a purely perceptual basis, and the infant in question does not necessarily display conceptual knowledge about the categories' contents.

Young children ... can form perceptual prototypes by learning to abstract the central tendencies of perceptual patterns. Forming discriminable categories, however, does not imply that the organism ... has thereby formed any theory of what the objects being categorized *are* or can use this information for purposes of thought.

The above discussion points to the necessity to distinguish between hearing and hearing, between linguistic and speech sound perception, between the ability to distinguish contrasts in sound and phonological contrasts. The latter is not necessarily fully developed at birth (cf. Stoel-Gammon and Dunn 1985:55, 57).

Edwards (1974) tested four hypotheses that related specifically to the relation between linguistic perception and production. Data from 28 children was collected (1;8-3;11) (1974:208) and tested with the basic assumption that 'correct phonemic perception of an opposition is acquired before correct production' (1974:207). The testing of the hypotheses resulted in eight findings, the first of which is most relevant here:

*Phonemic perception develops in a gradual and patterned way. The ability to discriminate consistently between two sounds, assign them to appropriate lexical items, and consistently identify the item in use is not complete at the beginning of the child's linguistic development but improves as the child grows older (1974:218).*

To assume that the child's underlying representation is complete at the onset of speech production, while perception is not yet fully developed, could only work in a fully innate account of acquisition. In a constructivist scenario, which is adhered to here (see 1. and 2.), however, the assumption of a full or adult(-like) representation at the onset of speech is rejected. To regard the child's acquisition from an adult point of view and to impose adult-based representation on the child is considered inappropriate here on the basis of the child's active and constructivist role in his own acquisition process (2.).<sup>2</sup>

#### 4.3 Perception/production model

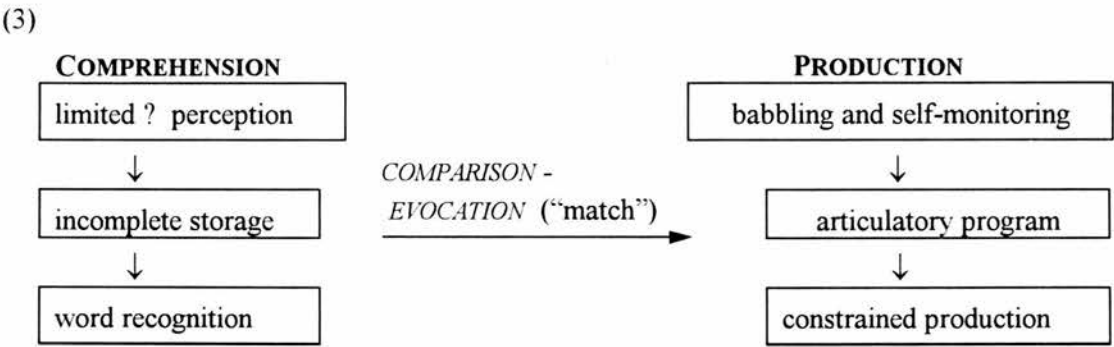
From the discussion in 4.1-2, the character of phonological processes has become clear as well as the implication of the assumption that they can account for the child's early realisations (namely, the child represents adult-like phonemic contrasts that are not evident in his output). Phonological

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<sup>2</sup> An aspect that originates in the assumption that also underlies phonological processes is the description of the child's output as "inaccurate", "erroneous", etc. These labels can only be regarded as being appropriate in an approach that does not consider the child's abilities as autonomous and his perception/production abilities as an independent system, and that somehow expects the child to drop his rules and speak like an adult.

processes are regarded as being descriptive. They are rejected here as a (insightful) theoretical construct on the basis that they consider the child’s phonological acquisition from an adult point of view. Those perception/production models that assume the child’s underlying representation to be essentially child-based, on the other hand, are considered to be of direct interest to the discussion here.<sup>3</sup>

For instance, Vihman (1991) presents a model that expresses the relationship between perception and production as part of a discussion on the comprehension and production of early words (1991:76). This model posits an incomplete storage component that is “matched” to the child’s articulatory program component, represented in (3). The child is thus assumed to have a perceptual representation as well as a representation that is the basis for his production, where both representations are based on the child’s abilities.



The assumption that the child has two kinds of representation is also inherent in the phonological processing model in Waterson (1987:110):

<sup>3</sup> As a consequence, the different generations of two-lexicon models will not be discussed here. These models regard the child’s output in terms of adult representation and phonological rules or processes; ‘Many children have systematic ways of reducing adult words to forms that fit within their production capacities, i.e., have rules or regularities’ (Menn and Matthei 1992:235, 239). See Kiparsky and Menn (1977) and Menn (1978b) for early views on the components and representations that are assumed in the child’s production/perception model, and Menn and Matthei (1992) for a more recent, detailed discussion.

(4)	INPUT	: Familiar language material.
	Processing	: Analysis by abstraction of perceptually salient features. Synthesis of features into possible phonetic patterns of the language.
	LEVEL OF REPRESENTATION 1	: Store of possible phonetic patterns in the language (no meanings).
	Processing	: Reception and recognition of phonetic patterns. Matching patterns with level of representation 2.
	LEVEL OF REPRESENTATION 2	: Store of lexical-phonological patterns (meanings included) with full phonetic specification, i.e. words.
	Processing	: Interpretation of phonetic patterns (through matching). Production of speech.
	OUTPUT	: Phonetic form.

The first level of representation is phonetic in nature and no lexical meaning is attributed to it. The second level of representation is regarded as being lexical/phonological. This representation stores the child's words in 'their full auditory phonetic form and provides for the identification of the input pattern by pattern matching' (1987:111). It also serves as the basis for the child's realisations. Waterson (1987:112) explicitly rejects the possibility that the child represents the adult phonological contrasts and/or structure at the onset of speech.

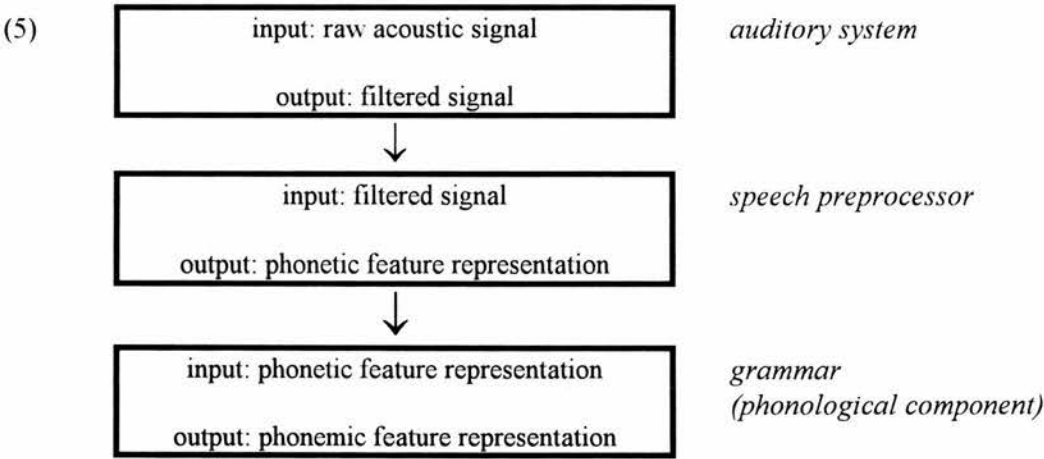
These two levels of representation are also posited in the model proposed by Hale and Kisko (1997a:232). Namely, their phonological component contains a phonetic feature representation, i.e. input, and a phonemic feature representation, i.e. output (see below). Hale and Kisko (1997a) discuss the phenomenon that the perceptual abilities of very young children (before 0;10-1;0) are not dependent on their language environment, amongst others. These children 'display acute perceptual sensitivity to the range of phonetic contrasts found in the world's languages' (1997a:229). Later, only the discrimination of some, and not other, sounds remains (cf. 4.2). With regard to this observation, they pose the question what in the human language processing system could have changed (cf. Werker 1991). They propose the following components (and their functions) to be part of the Speech Perception System (1997a:231):

- i) *The auditory system* : raw acoustic processing, directs signal to appropriate processor (e.g. speech v. music).
- ii) *Speech preprocessor* : converts processed acoustic signal to phonetic feature representations for subsequent manipulation by the grammar.

(Hale and Kisko (1997a:231, footnote) note that ‘the “speech preprocessor” undoubtedly represents a complex set of modules of the cognitive system. General perceptual strategies, short term memory access and recall, and a number of another non-speech-specific processors are certainly relevant (cf. Werker *et al.* 1996, Jusczyk 1997), although precise characterization of the nature and function of these components is still lacking. It does contain one speech-specific component, the one which actually generates the phonetic feature representations’.)

iii) *The grammar* : converts phonetic feature representations to phonemic representations for lexical access.

This is schematically presented in (5) (1997a:232):



Note that the grammar (phonological component) is assumed to be part of the child language representation. The speech preprocessor is regarded as being fleeting (Hale and Kisko 1997b). The work carried out by this component appears to be comparable to the processing in Waterson (1987) that is assumed to take place previous to the first level of representation (see 4). Also, previous to the input level in her model, Waterson (1987) assumes that there is a ‘first analysis of the input ... to distinguish between speech and non-speech ...; the latter includes bird-song, music, animal calls, thunder, noise of machines, etc., and will be analysed under a different heading from

speech' (1987:110). In Hale and Kisko (1997a), the result of this analysis is comparable to the filtered signal that serves as the input to the speech preprocessor in their proposal.

The Hale and Kisko (1997a) model appears to offer a plausible and straightforward account of the relation between perception and production on the basis of the discussion in 4.1-3.

With regard to the phonological component, and the relation between the phonetic and the phonemic feature representation therein, the proposal in Hale and Kisko (1997a) is not explicit. The phonetic input is the basis for the child's phonemic representation, i.e. phonological system, which develops gradually. The cognitive redescription model presented in Karmiloff-Smith (1993) appears to be able to express this development appropriately. Representational redescription is a domain-general, cognitive mechanism, and it acknowledges the child's cognitive abilities and his role as inventor in his own (language) development (see 2.4 and 3.2.5).

Representational redescription in the phonological component is envisaged as the distillation of information from the phonetic level of representation. This information is redescribed, or analysed and subsequently represented at a higher, more abstract level of representation that does not contain all the (phonetic) information expressed at the lower level. For instance, on a word scale, allophonic information is lost in the course of redescription and only contrastive information is retained. The redescribed representation of the child's realisations are assumed to reflect cognitively more complex information, such as generalisations regarding natural classes, CV structure, and (on a more abstract level perhaps) categorisation. Redescription takes place iteratively, and gradually, i.e. in the course of different representational levels, information is abstracted from the phonetic information that is the input to the phonological component. The highest level of representation is considered to be the child's phonological representation. This representation is also considered to steer the child's perception, and the difference between speech sound perception and linguistic perception (and the development from the former to the latter) can thus be related to the gradual change in the nature of the child's "awareness" (Ferguson and Farwell 1975).<sup>4</sup> Also, the discrepancy between the distinctions that the child is aware of in

<sup>4</sup> In the early stages of phonological development, when the child has not yet a phonological system with phonemic contrast (instead his sound contrasts are linked to a fixed CV structure; see 15.), it is assumed that representational redescription has abstracted the pattern(s) of what the child regards as the typical word. Subsequently, the child is perceptive to this pattern(s) in his speech



perception, and does not give evidence of in production can be accounted for on the basis of the phonetic information that is not sufficiently redescribed (“cognitively analysed”) to function as part of the child’s phonological system.

The Hale and Kissock (1997a) model in combination with the representational redescription mechanism proposed in Karmiloff-Smith (1993) is adopted here as the perception/production model that is part of the basic assumptions underlying the research.



## 5. Wordpatterns

Between the age of 1;10 and 2;2, a child realised a group of polysyllabic words according to a single output pattern (Stoel-Gammon and Dunn 1985:51 after Priestly 1977):

(1)	a.	<i>peanut</i>	[pijat]	e.	<i>farmer</i>	[fajam]
	b.	<i>panda</i>	[pajan]	f.	<i>seven</i>	[sejan]
	c.	<i>basket</i>	[bajak]	g.	<i>lizard</i>	[zijan]
	d.	<i>turkey</i>	[tajak]	h.	<i>rhinoceros</i>	[rajas].

This section presents an investigation into the nature, origins and representation of wordpatterns, mainly on the basis of three wordpattern studies, namely Waterson (1987), Menn (1978a) and Macken (1979).

### 5.1 Schemas, recipes and wordpatterns

#### 5.1.1 *Waterson (1987)*

As with a Piagetian schema or *gestalt qualität*, Waterson (1987) considers the child's perception to proceed from less to more differentiation. A child is viewed as perceiving 'some sort of schema in words or utterances through the recognition of a particular selection of phonetic features (the basic features) which go into the composition of the forms of the words or groups of words, and this recognition of a schema results in his producing words of the same type of structure for such adult forms' (1987:49). The recognition of differences within a particular type of structure increases as perceptual and articulatory skills develop. Features that are easy for the child to perceive are those that are already in his system as well as those standing out in an utterance (i.e. occurring more than once in the utterance, broader distinctions, etc.) (1987:41).

In order to account for the child's forms, both adult and child words were assigned to one of five structures in Waterson (1987), representing structurally different forms with regard to the basic features. On the basis of these structures, the child's early forms are accounted for, with reference to 'his ability to recognise schemata in the sound patterns of utterances' (1987:52). The schemas proposed in Waterson (1987:29) are a labial, continuant, sibilant, stop and nasal structure (see 5.4).

The child (0;10.14-2;2.0), the data of which Waterson studied, first discovered the sequence PlosiveVowel and NasalVowel, and many more words with these patterns were acquired. The second discovery was (PV)<sup>2</sup> and (NV)<sup>2</sup>, the reduplicated forms of the initial patterns, generalising



the structure he had already acquired to a wider set of words (1987:92). (For a discussion on how the child's acquires a growing number of contrasts, see 1987:66-68 and 1987:91-105.) Waterson's account is based on the concept of syntagmatic differentiation, i.e. contrast within the sequence of an utterance, which gives rise to the increasing complexity of the child's system (1987:91). For example, *bucket* is realised as [bʌbu bʌbu:] 1;5, [bæbu:] 1;6, and [bʌti bʌʔɪ] 1;7 (1987:87).

Waterson (1970:23) summarises as follows:

The child acquires the adult phonological system by way of his perception and recognition of certain limited features of the adult forms. These he reproduces and they form the basis for his own simple system, i.e. he observes patterns of features in the adult forms and makes his own patterns in response with related features. As his perception improves, the responses change. He discriminates more and attempts to reproduce more. His own structures then change and become more differentiated. These new structures then condition his responses to his input and this continues until he acquires the adult system, i.e. he does more than a simple habitual response; the increase in perception and greater discrimination bring about some reorganisation which results in new patterns of responses leading to a change from the old patterns to new.

### 5.1.2 Menn (1978a)

On basis of the use of consonants in a child's words (12;8-1;8.22, 96 sessions), it is observed that he 'started with a small repertoire of output word forms, [and] that he added to them slowly' (1978a:97). This is in agreement with the view that initially children tend to have a minimal variety of syllable shapes in their output forms. Such a limited output repertoire could be achieved by either selecting words with a similar structure in the target language or by modifying adult words in such a way that their form is similar to the child's output form. (This implies that the child perceives and probably has access to a representation of the adult word (see below).). Menn (1978a, Ch. IV) discusses hypotheses about how the child accomplishes that. First, however, she relates the notions of "having the same shape" and "limited output repertoire" to Ingram's (1973, 1974a) idea of *canonical form*, i.e. 'a partial specification of a string of phonemes (or other representation of the sound of a word) which encodes the output restrictions obeyed by a set of words' (Menn 1978a:97).

Once the child has discovered the encoding or "recipe" for producing a word, he will try to use it in appropriate situations, i.e. when he perceives a similar pattern (see 5.3). According to Menn (1978a:109) 'variations within familiar patterns are easier to master than whole new patterns'. New words are thus acquired through the adaptation of an old recipe for a new acoustic situation.

This reduces the complexity of a new task, which in turn makes it possible to concentrate on an unfamiliar aspect. So, the child is assumed to use a limited number of recipes, i.e. 'complex set[s] of articulatory instructions ... associated with the sound of a word' (1978a:109). These are used to recognise (similar) words and produce them: 'a small variation on the recipe may give success on the second word' (1978a:109). The canonical form is thus adhered to. (See 5.4.)

This view makes a claim about the origin of rules in child phonology (1978a:130):

... they arise as changes in the shape of adult words to reduce the number of canonical forms, either by overgeneralisation of existing patterns when the recipe for a new word is being worked out, or as consolidation [i.e. phonological reorganisation] among similar recipes.

The recipes on which the child's words are based are also maintained because adult words that do not confirm the existing recipes are avoided. The range of output forms remains restricted. Phonological selection is thus claimed as the child 'really did avoid certain adult words because of the sounds they contained' (1978a:110). As 'avoidance of a sound implies the ability to discriminate it from sounds one does attempt to say' (1978a:121), the view that phonological selection is based on avoidance relates to the discussion of the presence of the adult representation in the child's language component and thus his acoustic perception/awareness of sounds he does not yet produce (see 4.2). In this context, note the shift in focus with a later view expressed by Menn, as reported in Schwartz and Leonard (1982:333): 'children do not avoid certain words, but instead simply fail to select them'. Phonological selection, then, is the non-selection of words because of the sounds they do not contain, i.e. the sounds that constitute the word recipes. This formulation succeeds in evading the issue of the child's perception and/or representation of adult words.

### 5.1.3 *Macken (1979)*

Macken (1979) advocates an analysis based on words and their prosodic treatment in child acquisition data, on the basis of data from the consonant acquisition of a Mexican-Spanish child (1;7-2;1) (the child produced 12 words at the beginning of the observation period and 150 at the end) (1979:11). It is claimed that, during the child's early development, a word-based, rather than a phoneme-based, analysis: i) describes the development of the consonant structure of the words, ii) accounts for several unusual segmental correspondences, and iii) captures significant facts about frequency of word types and phoneme-in-certain-positions.

With regard to these word types (iii.), the child's realisations are assumed to illustrate several types of wordpatterns that develop in a regular way over time (1979:25). Also, evidenced by the data, the following processes are claimed to apply: syllable reduction, metathesis, substitution and consonant cluster reduction. These processes describe how words were treated to fit the output form, i.e. the wordpattern. With regard to the processes, their variable nature is pointed out, and illustrated with the process of syllable reduction which 'operated to delete either the initial syllable(s) or the medial one ... [t]he choice which was deleted depended crucially on the consonants in the syllables' (1979:25). Namely, in the study here, the wordpattern *labial+dental* constituted the subject's preference and words were "processed" accordingly:

- |     |   |                  |            |           |
|-----|---|------------------|------------|-----------|
| (2) | a. if labial initially, then reduction medially | <i>manzana</i>   | 'apple'    | [məɲna]   |
|     |   | <i>pelota</i>    | 'ball'     | [p'atda]  |
|     |   | <i>vestido</i>   | 'dress'    | [b'itʃi]  |
|     | b. if labial medially, then reduction initially | <i>comiendo</i>  | 'eating'   | [mə'ɪnnu] |
|     |   | <i>zapato</i>    | 'shoe'     | [pwatt'o] |
|     |   | <i>elephante</i> | 'elephant' | [batte]   |

(The vowel in the stressed syllable was mostly retained.) The validity of wordpatterns is evident in the way syllables are deleted, namely 'in a flexible manner consistent with the goal of producing a favoured output form' (1979:18). Syllable deletion and consonant harmony are some of the means through which constraints (regarding word length, the complexity of the child's phonological system and of the combination of sounds) 'operate universally to affect simplification' (1979:19) (cf. phonological processes). Metathesis is proposed to account for the production or achievement of the favoured co-occurrence of consonants as well (1979:41). The processes that underlie the observed metathesis and that achieve the wordpattern *labial+dental* for the target *elephante* 'elephant', for example, are the following:

- |     |                    |                 |                  |   |
|-----|--------------------|-----------------|------------------|---|
| (3) | <u>processes</u>   |                 | <i>elephante</i> |   |
|     | syllable reduction | <b>elefante</b> | [fante]          |   |
|     | substitution       | f → b ~ p       | [b/pante]        |   |
|     | CC-reduction       | nt → t          | [batte]          | <u>(metathesised) child realisation</u> |

The force exerted by preferred word patterns provides a plausible explanation for the otherwise inexplicable treatment of many adult words and phonemes. However, the same "pattern force" which frequently caused words to change phonological form also caused variation which was not so easily interpreted (1979:32-33).

... the evidence for the primacy of word patterns as the organizing principle of [Macken's subject's] early phonological development has been the following [according to Macken (1979)]: (1) all words had a consistent pattern form; (2) the gradual development of classes of word patterns can best be described as a process by which new patterns resulted from the expansion of previously acquired word patterns; (3) some words changed pattern over time as new words patterns are learned; (4) three of the four simplifications processes operated to produce favored word patterns as output; and (5) several unusual phonological substitutions and some phonetic "slips" can only be explained by the notion of "pattern force" (1979:34).

The development in the realisation of target words by the child is regarded as being a consequence of the (different) hypotheses the child makes concerning the similarity of words. More generally, the choice of target words and the assignment of wordpatterns to these words by the child 'seem to lie in some general prosodic similarity of the words involved' (1979:39). This phenomenon is related to the schemas proposed in Waterson (1971a, b).

Wordpatterns are central to Macken's (1979) proposal and consequently the word is adopted as basic unit in the child's early phonological organisation. The realisation of words by the child involves the processing of the target word to fit the wordpattern, i.e. preferred output form, by means of processes. The status or nature of these processes is not explicitly discussed, and generally they are considered here to be undesirable (see 4.).

#### 5.1.4 *Conclusion*

The three proposals discussed here (5.1.1-3) all present a structure observed in the child's output with a particular syllable shape and a particular configuration of sounds, i.e. a wordpattern or word recipe or scheme. The wordpattern claim is based on the observation that a limited set of features and a limited structure represent the output of the child in the early stages of phonological acquisition. The wordpattern also serves as a means of recognising words in speech as its structure is imposed on the child's perception of the world (cf. 3.2.2; see also 5.3). With the development of the child's skills, his increased abilities are reflected by syntagmatic differentiation within the wordpattern, amongst other things. Subsequently, more complex patterns occur (cf. 3.2.5).

The proposals in both Macken (1979) and Menn (1978a) entail phonological processes or rules. This implies that the child has a more complex representation that serves as the input to the rules/processes than is evident in his output. (See the discussion on the undesirability of processes

in 4.1.) Waterson's (1987) account presents a clear picture of what is selected by the child and what is underlyingly represented by the child. This appears to be mainly because of the emphasis that is placed on the autonomy of the child's linguistic abilities and his phonological system, without making reference to phonological processes.

## 5.2 From protoword to wordpattern to word

With respect to the development of the phonological system in the early stages of the child's acquisition process, Ferguson and Farwell (1975) present a view that has its roots in 'a phonetic core of remembered lexical items and articulations which produce them' (1975:437). Besides the notion of contrast, i.e. the distinctive use of sound differences, they thus emphasise the primacy of lexical learning. The child's phonetic core of lexical items is regarded as the foundation of an individual's phonology which he abstracts and generalises; 'he gradually imposes increasing phonological organization on his stock of articulations and lexical representations' (1975:437). According to Ferguson and Farwell (1975), 'phonological development includes the gradual development of phonological awareness, i.e. the child's ability to deal explicitly with phonological elements and relations' (1975:438).

The first "words" that the child acquires are thus important as they form the basis for his phonological system. The phonological structure that is gradually imposed on these words constitutes the onset of his phonological system. Wordpatterns or recipes can thus be considered to idiosyncratically descend from an individual's set of first words. The child also perceives his input in terms of his first words (see 5.1.4 and 5.3).

The origins of the child's first "words" can be traced back to 'idiosyncratic expressions used by prelinguistic infants with apparently consistent meaning', which are discussed in Blake and Boysson-Bardies (1992). They investigate cross-linguistic patterns of babbling and sound-meaning relations therein. These 'idiosyncratic expressions' are also referred to as 'clusters of consistent sounds exhibiting a functional content' (Gilles and de Schutter 1986:127). This prelinguistic phenomenon is considered in terms of a bi-stratal system - meaning is mapped onto sound - which develops in a continuous way into a tri-stratal system when syntax becomes established and relates the two initial components (Blake and Boysson-Bardies 1992:53). In the discussion here, the focus is not on the arguments in favour of a functional pre-linguistic semantic

system, but rather on those aspects concerning the “freed-up” use of the protowords as mentioned in Gilles and de Schutter (1986).

Gilles and de Schutter (1986) discuss PCF's (phonetically consistent forms); a PCF is a type of vocalisation between prelinguistic babbling and early words. They identify three stages: an onset, a plateau stage (up till 50 word stage) and a rapid growth in the acquisition of PCF's. The plateau stage is regarded as a period of qualitative changes, namely decontextualisation. This entails that the use of PCF's is both generalised and defunctionalised. The scripts and references are no longer used in a particular context only. Qualitative change thus affect the semantic and phonological aspect of the child's linguistic system. After the plateau stage, the child's vocabulary expands, rather than the structure of acquisition, representing quantitative change (1986:127-30). (See also 3.2.1.) This scenario can also be recognised in the development of Menn's (1978a) subject: '[t]he functional development of Jacob's word was from ritual accompaniment of his own action towards flexible instrumental use of language for varied ends' (1978a:159).

The child's first “words” or word-like utterances are assumed to have a profound influence on the course of his early phonological development. The use of first “words” or protowords is contextualised, i.e. associated with a particular action and object. A major cognitive step towards the coming into existence of the child's phonology is the freeing-up of the protowords from their context. Words now need to be recognised on the basis of their sounds and the child thus needs an acoustic identification. These first phonetically-based words are characterised by a limited structure and a limited set of features, i.e. wordpatterns (see 5.1). Wordpatterns are not linked to context and constitute the basis for the child's acquisition of a phonological system expressing the contrasts that are evident from and gradually developing within the framework of the child's first words. When the child's production is generally no longer bound to particular sound structures, the wordpattern has become a word.

### 5.3 Reinforcement and homonymy

The “preference” that a certain child displays for a particular phonological structure as evidenced in his output forms could be linked to the first lexical items he has acquired (5.2). This structure is regarded as important for the development of the child's (phonological) system, amongst other things. The wordpattern can be regarded as a guideline for the child to recognise words in the acoustic input, and the other words that are subsequently acquired by the child are claimed to



relate to wordpatterns. Schwartz and Leonard (1982) studied this phenomenon extensively. Their findings are discussed below.

Schwartz and Leonard (1982) examined phonological selection and avoidance and the observation that '[c]hildren appear to select words with certain phonological characteristics and avoid words with other characteristics, following a variety of individual patterns' (1982:319), based on syllable structure and/or sounds of adult words. Within an experimental paradigm, they presented 12 children (between 1;0.21-1;3.15) with 16 made-up lexical concepts, i.e. a nonsense word and four exemplars as referents for that word. Half of the nonsense words were structurally unlike the child's productions or attempted adult words - the OUT words. The other eight words 'had syllabic structures and were comprised of consonants which had been evidenced in the child's productions' - the IN words (1982:322). The nonsense words were constructed individually for each child, the referents remained constant across children (1982:321). The children were taught these nonsense words. The accuracy of the attempted experimental word was determined on basis of the consonants (1982:328).

The results of the experiment indicated that '[t]he children acquired ... a greater number of words with phonological characteristics that were consistent with their systems than words with phonological characteristics that were inconsistent with their systems' (1982:326). Also, IN words appeared to be attempted earlier than OUT words. These findings provide 'evidence of the influence of selection and avoidance constraints upon children's lexical acquisition' (1982:328); words that are consistent with their limited phonologies are apparently more likely to be acquired and to be acquired more rapidly, i.e. fewer prior presentations.

Note, with regard to the child's expanding vocabulary in terms of structural characteristics, that children are not said to abandon the strategy of avoidance. Rather, they no longer fail to select words because they have become more skilled, and the constraints on their output forms are relaxed (1982:320, 333).

The child's early acquisition is based on the perception and recognition of a limited set of features in the adult forms (cf. 5.1.4). The child "manages" the production and/or acquisition of new words on the basis of patterns he has already mastered, thereby increasing the occurrence of this pattern. Phonological selection thus reinforces existing structure. This can be explained in terms



of Vihman (1991:76) who proposes a comprehension and production-model for the child's early words (see 4.3, Figure 3). The comprehension part of this model has an incomplete storage component that is matched with the child's articulatory program in the production part.

Once [an auditory feedback loop] has been established ... such that upon producing a sequence [baba], the child is stimulated to repeat it, the way is open ... for the sound of an adult word such as *baby*, *bottle*, or *bye-bye* to produce the same effect, resulting in apparent imitation ... This would provide a plausible developmental origin for the perception-production link, creating "perceptual units of imitation" (1991:76).

The influence of wordpatterns on the child's production also becomes evident from the study discussed in Vihman (1981). This article looks at different kinds of lexical errors children make, based on similarity in sound. One such phenomenon is the homonym strategy, 'which involves an active use of word blends or mergers to reduce the number of differing phonological output patterns' (1981:240).

Waterson (1987:28) also discusses homonymy in relation to the data from her son who had several homonymic pairs (1;5-1;6): [væ] *fly*, *flower*; [ɪʃ] *fish*, *fetch*; [ʊʃ] *fish*, *vest*; [bæbu:] *Bobby*, *bucket*. She attributes these forms to similarities in the child's perception of adult forms as the child apparently perceives utterances as whole units, and distributes features in his attempt to pronounce the word. (See also Waterson 1987:56.) A related phenomenon is reported in Macken (1979) where several misconceptions are discussed, for instance, *león* 'lion' was repeated as *avión* 'airplane', *gallo* 'rooster' as *caballo* 'horse', and *taza* 'cup' as *casa* 'house'. The words involved are 'phonetically similar but rarely visually or semantically similar' (1979:16). These misconceptions are accounted for with reference to the similarity in general prosodic shape and the child's holistic (acoustic) perception of these words.

#### 5.4 Representation of wordpatterns

The (representation of the) development of a child's wordpatterns in the course of his early phonological acquisition is one of the issues related to wordpatterns discussed in Macken (1979). It is argued elsewhere 'that restrictions on syllable structure and on the co-occurrence of consonants limit in systematic ways the complexity of all words ..., and that the development in complexity of [the child's] production can be best accounted for in terms of successive modifications of these restrictions', i.e. wordpatterns (Macken 1978:220). Menn (1978a) and Waterson (1987) also present (some of) the wordpatterns they propose in relation to the output of

a certain child and their developmental changes. The representation of wordpatterns in these three proposals is discussed below, in the context of developmental change.

Macken (1979) represents the wordpatterns of her Mexican-Spanish subject in terms of phonemes. The consonant phonemes that occurred in non-final position and were acquired by the child in the course of the period 1;7-2;1 (stages I-VII) are presented (1979:36, Table 4). Here, the consonants acquired in the first three stages are given in (4a.). The child's realisations of two words during I-III are provided in (4b.) (1979:30, Table 3): *manzana* 'apple' and *Fernando* name.

(4)		a. acquisition of consonant phonemes in non-final position	b. <i>Fernando</i> name	<i>manzana</i> 'apple'
stage	age			
I	1;7	/ p t n m w j /		[mə na]
II	1;8.7	/ k /	[manno wanno nanno]	
III	1;9	/ b tʃ l /	[ma no janto]	[bʷannə pʷannə manna]

The representation of these two words gives rise to the following queries. Firstly, in stage II, *Fernando* is assigned to the wordpatterns [m\_n\_] on the basis of the realisations [manno wanno nanno] (1979:30, Table 3; cf. 1979:26, Table 2). /m n w/, however, have phonemic status before stage II (4a.). On the assumption that the variable realisations of the same target word are, by definition, not contrastive within the same developmental stage, the contrastive status of the initial consonants in combination with one common wordpattern for the three realisation of *Fernando* appears odd. Secondly, *manzana* is realised as [bʷannə pʷannə manna] in stage III. It appears, on the basis of these realisations that *manzana* comes under two wordpatterns: [m\_n\_] and [b/p\_n\_] (1979:30, Table 3). If /m/ and /b/p/ are contrastive, as they occur in different wordpatterns, then words based on the two patterns mentioned above are basically different words. In this light, it is difficult to explain how different realisations of a word can be regarded as different words.

From the discussion of the *Fernando* and *manzana* examples it has become clear that the proposed phonemes and the wordpatterns do not seem to be in agreement with one another. More generally, it appears that the specification of wordpatterns by means of phonemes is too specific.

An alternative is offered in Waterson (1987) who proposes "cover symbols" to describe the wordpatterns observed in the data of her subject.

Central to Waterson's (1987) proposal concerning phonological development is the gradual increase of phonological contrast in the child's system and a simultaneous increase in the number of phonological segments that represent his inventory. The development of (the representation of) *pudding* illustrates this gradual increase (1987:16-18):

(5)	age	realisation	pudding	syllable structure	h prosodies	systems
	1;6	[pupu]		CV		(P <sub>p</sub> V) <sup>2</sup>
	1;7	[bubaiɲ]		CV CVC	<sup>h</sup> CV <sup>h</sup> CVC	P <sub>p</sub> VP <sub>p</sub> VN <sub>k</sub>
	1;7	[pupəɲ bupəɲ]			<sup>h/h</sup> CV <sup>h</sup> CVC	
	1;8	[budun]			<sup>h</sup> CV <sup>h</sup> CVC	P <sub>p</sub> VP <sub>t</sub> VN <sub>t</sub> *
	1;8	[pudun]			<sup>h</sup> CV <sup>h</sup> CVC	
	1;8	[pudiɲ]				P <sub>p</sub> VP <sub>t</sub> VN <sub>k</sub>

\* new contrast P<sub>p</sub>-P<sub>t</sub>, however, not more contrasts as h prosodies are not different here (see *Firthian notation* below).

The description of consonants in Waterson (1987) is by means of different *systems*, representing the main classes: nasals (N), stops/plosives (P), fricatives (F), continuants (K), sibilants (S) and liquids (L). These systems are, on the one hand, specified by means of *exponents* and, on the other, *h prosodies*. The latter represent: breathiness and absence of voice: <sup>h</sup>, and non-breathiness and possibility of voice: <sup>h</sup>. Consonant systems and h prosodies correspond to the manner of articulation. The exponents express place of articulation and related to the articulatory consonant specification: <sub>p</sub> labial, <sub>t</sub> apical and <sub>k</sub> dorsal (velar or palatal) (1987:x, 11-13, 29-40; cf. Waterson 1970).<sup>1</sup>

As becomes evident from (5), the development of the child's labial structure that is the basis for his realisation of *pudding* gradually becomes more complex. Waterson (1987) represents all phonetic aspects observed in the child's realisations, and not just the phonemically contrastive

1 Vowels are represented in the vertical dimension of the quadrilateral vowel diagram by vowel grade:  $\alpha$  low,  $\epsilon$  middle and  $\iota$  high, in combination with a superscript indicating the horizontal dimension, which is regarded as a vowel prosody. The vowel exponents are <sup>y</sup> frontness, non-rounding; <sup>w</sup> backness, generally accompanied by lip-rounding; and <sup>°</sup> neutral as to frontness and backness. Lip-rounding and lip protrusion are expressed by <sup>r</sup>, their absence by <sup>ˆ</sup> (Waterson 1987:xi).

characteristics. This approach is in accordance with the Firthian notational tradition. This theory adheres to representation that includes i) a finite set of structures composed of sequences of C and V units, ii) systems at C and V places in the structure, and iii) units which have relevance to the whole or part of the structures, viz., prosodies (1987:7). The cover symbols that are used, as part of the Firthian-based notation of consonant systems, do not facilitate the expression of a less specific representation, because their specification is supplemented with the specification of prosodies and exponents. Overall, a segment in the child's utterance receives a full phonetic specification (cf. Figure 4 in 4.3). Variability is simply reflected through the specification of the variable options, cf.  $^{h^h}CV\ ^{h^h}CVC$  in (5).

Cover symbols are also part of the Menn (1978a) representation of wordpattern or recipe development. In the output of her subject, different sets of data are recognised on the basis of the canonical forms observed in the data. (96 recording sessions during 1;0.8-1;8.22, representing eight developmental sets of canonical forms). For instance, *taptap* is presented as an attestation of the (dV)<sup>1,2</sup> pattern in #2 (1;2.24-1;3.16); realisation [dædæ]. In the next set #3 (1;3.22-1;4.12), *taptap* [tata] comes under a more general pattern, namely (DV)<sup>1,2</sup> (with vowel specification [+low, +front]). (*D* denotes dental stops, whether voiced or unvoiced (1978a:99).) Other realisations for the same recipe are *bye-bye* [dada], *doll* [daw] and *there* [de]. In this light, the earlier pattern specification (#2) (dV)<sup>1,2</sup> appears to be too specific as there does not seem to be a distinction in voice or place yet; the *D* specification would suffice. A similar observation can be made regarding the kV(k(V)) pattern in #5 (1;4.30-1;5.25). The velar stop in this patterns is established on the basis of *quack* [kʌk kæ], *car/truck* [ka], *cracker* [kaka] and *key* [k<sup>hi</sup>i]. In #6, however, the realisation of these targets are subscribed to a more general pattern that does not specify a place contrast, namely C<sub>1</sub>V(C<sub>1</sub>(V(C<sub>1</sub>))) (C may be weakened to ?; C is not labial; C# = [k]).

From the discussion in 5.1-3, it has become clear that the wordpattern development is assumed to proceed from less to more specific, similar to the gradual development of the child's phonological awareness. The analysis in Menn (1978a) and the proposed wordpatterns do not seem to subscribe to this general developmental characteristic. As a consequence, the realisation of a target word changes from a more to a less specific pattern, e.g. from a pattern defined in terms of inappropriate (adult-based) phonemes to one defined by cover symbols (e.g. *C*, *D*), i.e. less

specific phonemes. This is unfortunate, and the proposal does not appear to be able to make the most of the wordpattern idea.

### 5.5 Summary

As there is individual variation in the protowords that children acquire, i.e. consistent pre-linguistic sound sequences with a consistent meaning (cf. PCF, 3.), there is individual variation in the wordpatterns observed in children's output (cf. 5.1.1-3). Namely, the child's word-like utterances, characterised by a particular syllable shape and a particular configuration of sounds, are based on these protowords, which can thus be considered to be influential for the child's phonological development. Wordpatterns, in turn, are the basis for gradual expansion to result in the child's phonological system (5.2). This lexical primacy in early phonological development also affects the child's perception as he imposes the pattern on his input and also bases the acquisition of new words on old patterns. The influence of wordpatterns on a child's output is illustrated by homonymy (5.3).

Regarding representation, the three proposals discussed, Waterson (1987), Menn (1978a) and Macken (1979) (5.1), present the development of specific wordpatterns observed in the output of their subjects (5.4). The representation of wordpatterns in terms of (adult-type) phonemes appears to be too specific as it can not capture the variable realisation of a pattern well (though this also depends on the phoneme status assigned to phones (Macken 1979)). The use of "cover symbols", representing a group of segments, can be considered to be inherently appropriate. However, regarding the development of the wordpattern, it is assumed that its nature gradually changes from less to more specific. So, the representation of a pattern is expected to proceed from cover symbol to phonemes, not *vice versa* (Menn 1978a). Waterson (1987) also employs cover symbols in the context of the Firthian notation she adopts. However, to present all phonetic information rules out the possibility to employ cover symbols to express phonetic variation within a wordpattern or schema. So, none of the proposals discussed here can be concluded to be completely successful.

Wordpatterns provide a useful concept to account for and understand the nature of this aspect of the phonological acquisition process (provided they express a child-based approach to acquisition, i.e. do not incorporate phonological processes; cf. 5.1.4). However, they should be regarded as a consequence of other factors, such as the child's limited abilities (perceptual and phonological)

and cognition, amongst others, rather than a separate phenomenon. It has become clear that describing the child's output on the basis of wordpatterns requires a notation that can express segments in terms of less, rather than more, specific phonemes.

## 6. Consonant harmony

The discussion on the acquisition of place of articulation (and its representation) in the literature consists to a large extent of the examination of assimilation processes that are evident in a child's output in the early stages of phonological acquisition. In this respect, acquisition of place and consonant harmony, or non-contiguous assimilation, are closely related. Consonant harmony is considered here on the basis of various proposals, namely Iverson and Wheeler (1987), Levelt (1993) and Cruttenden (1978) (6.2). First, however, the study described in Vihman (1978) is discussed; this study is generally presented as a reference point for the discussions on consonant harmony in child language (6.1).

### 6.1 **Vihman (1978)**

The aim of the study reported in Vihman (1978) is to find answers to the following questions, amongst others, i) whether consonant harmony is universal in child language, ii) what relation child consonant harmony has to adult phonology, and iii) to what extent the language the child learns influences the child's strategies (1978:283). In order to consider these questions, data of 13 subjects was analysed, i.e. Chinese, English, Estonian, Czech, Slovenian and Spanish child utterances (1978:285). As not all available data was complete, the choice of data is largely determined by its format (*complete* in the sense that it did not include all the forms that were recorded at regular intervals or recorded during a specific period in the case of diary studies) (1978:283).

The utterances of each child are categorised under the following five types on basis of the variant realisations of target words (for more detail, see 1978:288-89) (with regard to the description of the consonants analysed, only the place and manner of articulation are taken into account):

- a. *consonant harmony* - place and/or manner agreement between two non-contiguous consonants that are different from the target consonants in that respect.
- b. *consonantal contrast* - no harmony and two non-contiguous consonant different or in a different order from the target that contains at least two contrasting consonants.
- c. *consonant deletion* - loss of one or more consonants in all variants of a word so that there is no consonantal contrast, whereas the target word has.
- d. *no contrast* - the adult target does not contain two non-contiguous contrasting consonants regarding place or manner of articulation.



- e. *pseudo-harmony* - the regular consonant substitution by the child results in a merger of the contrast of two consonants that are contrastive in the target word.

The role of consonant harmony is discussed on the basis of this categorisation and the percentage of the words that are scored for each category for each child. Adopting the criterion that over 5% use of either of the categories is considered to be significant, seven of the thirteen children used consonant harmony and ten of them employed consonant deletion (1978:297). Furthermore, it is concluded that consonant harmony is not universal (1978:321), nor is it regarded as innate in the sense of a phonological process (cf. Stampe 1979) (Vihman 1978:322). (For a discussion of the data analysis, see 1978:291-320.)

Those cases of harmony that appear to continue longer than other signs of phonetic immaturity or incompetence are suggested to possibly function in a similar way to adult alliteration. When concluding on the function of consonant harmony, Vihman (1978) takes into account the assumption that consonant harmony is related to the adult use of alliteration (1978:327), and its function as a mnemonic aid. On the other hand, Menn's (1974) hypothesis is referred to, namely that 'consonant harmony serves to increase "the redundancy of the articulatory instructions necessary to produce the child's forms"' (1978:328). Finally, Vihman (1978) suggests that

... the redundancy of consonant harmony forms ... in some sense simplifies the child's mnemonic problems in recording and storing a rapidly growing lexicon (1978:328).

In the output of the children studied, this is illustrated by the apparent motivation with which consonant harmony was applied: to solve segmental problems or to deal with long words, for example (1978:303-4, 318). (Cf. II7.2.)

Vihman (1978) conducts the discussion concerning the presence/absence of consonant harmony in the data of the 13 children studied without reference to (the development of) the phonological systems of these children. The assignment of the child's realisations to the categories discussed above is done on phonetic grounds only. On the assumption that a lack of place contrasts between phonetic segments implies the absence of a phonological place specification for these segments, the development of the child's phonological system at the time of utterance is regarded as being relevant. Namely, non-specification of segments could provide an insight into the cause and nature of harmony or assimilation processes. Vihman's (1978) account of consonant harmony can thus be said to be too general; the phonetic forms that constitute the basis for her study are taken at

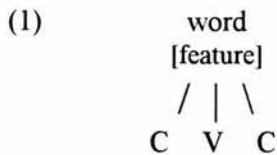
face value. In this respect, the child data used can be said to be analysed from a global rather than an in-depth point of view.

In the proposals discussed in 6.2, the core of the arguments presented consists of more detailed discussions regarding the motivation for consonant harmony and its phonological representation.

## 6.2 Explanations of consonant harmony

### 6.2.1 *Iverson and Wheeler (1987): hierarchical structures*

Iverson and Wheeler (1987) posit the claim that ‘many of the common processes in child phonology’ (1987:249-50) can be accounted for with reference to the incorrect hypothesis that children make, namely that phonological features are hierarchically organised in constituents. The processes referred to are deletion processes, reduplication and assimilation. Assimilation processes (e.g. velar, nasal and labial assimilation) are assumed to be caused by the association of features at the word level, in accordance with the child’s hypothesis, rather than at the segment level. On basis of a CV word structure, the child develops a CVC template as he recognises ‘that words may end in consonants’ (1987:251). When the child still regards features to be properties of words, rather than of segments, the CVC template has the following form:



A child that has [–anterior] associated at the highest hierarchical level of this word template, for instance, will associate any word containing a back consonant with this word structure (1987:251). This results in velar assimilation; [gag] *dog* /dɒg/ and [kok] *coat* /kɒt/ (1987:252).

The subsequent development is regarded as follows (1987:253):

Eventually, the child will discover that features like [anterior] ... are distinctive at the segmental level and they will no longer have entire words within their domain. The prediction is that once phonemic contrasts have been established in the child’s grammar and features have, in effect, worked their way down to the segmental level, harmony processes like velar assimilation will cease to be evident.

Once the features have been “segmentalised” and each segment is specified individually, assimilation processes do no longer occur. In this view, assimilation is regarded as being a consequence of the developmental stage of the child’s phonological system.

### 6.2.2 Levelt (1993): vowel-consonant interaction

Consonant harmony is reanalysed as vowel-consonant harmony in Levelt (1993).<sup>1</sup> The initial motivation for this are forms like [plɔm] *ballon* 'balloon' /bɑ'lɔn/ (1;7.9) and [pum] *schoen* 'shoe' /sχun/ (1;9.24). According to Levelt (1993:38), the realisation of *ballon* presents a difficult case for a consonant harmony account as [l] in [plɔm] intervenes between assimilation source, i.e. /p/ (*sic*; what is expected here is [p]), and assimilation target, i.e. /n/ (*sic*). The apparent labial harmony in [pum] for *schoen* is also regarded as problematic as it 'appears to be a Consonant Harmony case ... [while] there is no Labial consonant in the adult word ...' (1993:38).

Furthermore, planar segregation is presented as one of the two ingredients prerequisite for a consonant harmony account. As consonant assimilation is regarded as a process between two non-adjacent consonants, '[a]n almost inevitable consequence is ... to assume that children have an underlying representation whereby consonants and vowels reside on different planes' (1993:39). Following McCarthy (1989), planar segregation is rejected for Dutch (child) language as it does not satisfy the following requirement (Levelt 1993:40):

A language has sufficiently restricted root constraints - constraints on the sequence of consonants and vowels in the stem -. This is present in languages that have, for example, syllables only of the type CV. The sequencing of consonants and vowels is thus predictable.

On basis of the conclusion that the position of the vowel in relation to the consonant is not predictable in (child) Dutch, planar segregation is rejected (for instance, in the output of one child the following sequences occur: VC, CV, VCV, CVV, CCVCV, CVCCV, CVC CCV and CVCV) (1993:41).

The second structural aspect of consonant harmony discussed is underspecification, in particular coronal underspecification. On the assumption that coronal consonants are not specified underlyingly, these segments are predicted not to function as assimilation triggers (cf. II4.). However, there are ample examples in Levelt's data, i.e. the ChildPhon data (see II1.2.1), that have a coronal segment as trigger consonant. It is therefore concluded that 'an account of Consonant Harmony in terms of a combination of a consonant underspecified and one specified for place in a word, triggering an automatic feature filling process makes the wrong predictions' (1993:44).

<sup>1</sup> This proposal is also presented in Levelt (1994), Ch. 4. For a discussion of this chapter, see II2..

The next step in the Levelt (1993) argument is to look at the circumstances in which harmony occurs. It is observed that the vowel between the two consonants involved in the consonant harmony (source and target in the assimilation process) shares the same place of articulation with the source target. This could point to the vowel as the trigger of “consonant harmony”, rather than the consonant non-adjacent to the target consonant. Examples that provide confirmation of this scenario are cases where ‘consonant X would be substituted for [sic] consonant Y with the adjacent vowel being Y too and no other consonant (of type Y) in the adult model word’ (1993:46). Examples are from the data of one child, Eva (1993:46):

(2)	a.	<i>schoenen</i>	‘shoes’	/sχunə/	[umə]	1;4.12
	b.	<i>toren</i>	‘tower’	/torə/	[bowə]	1;6.1
	c.	<i>klok</i>	‘clock’	/klɔk/	[pɔt]	1;7.15
	d.	<i>beer</i>	‘bear’	/beɪ/	[dɛ]	1;4.12
	e.	<i>weg</i>	‘gone’	/vɛχ/	[dɛχ]	1;4.26

Consonant harmony is thus reanalysed as vowel-consonant interaction. (III7. presents and investigation of the VC harmony claim as part of a study into the place specification (development) during early phonological acquisition.) The advantages of this type of vowel-consonant harmony is that consonant harmony and VC interaction can now be regarded as structurally similar processes according to Levelt (1993). The vowel is the provider of the place feature to which the adjacent consonant assimilates. Also, it is claimed that this analysis mirrors the adult situation better, as consonant harmony is rare in adult language and vowel-consonant interaction is commonly observed in relation to secondary and primary place features (1993:48).

### 6.2.3 Cruttenden (1978): strength hierarchy

Assimilation in child language is discussed by Cruttenden (1978) in relation to the observation that ‘[i]n the general development of children’s sound systems there appears ... to be a strength scale of the type:’ labials > velars > apicals (1978:373). The discussion concerns assimilation of place of articulation only. Cruttenden (1978) presents the instances of assimilation of one child (1;6-2;2) collected during a period of eight months. The different possibilities of assimilation are

considered and compared with the actual assimilated realisations in the observation period. It is concluded that labials are the strongest<sup>2</sup> (1978:373-74);<sup>3</sup>

(3)	<b>apical + labial</b> ↓ <b>labial</b>	<i>shopping</i> <i>rabbit</i> <i>sleeping</i>	[pɒpɪn] [babi] [fɪfɪn]	/ʃɒpɪŋ/ /ræbɪt/ /slɪpɪŋ/	<b>apical + labial</b> ↓ <b>apical</b>	-
	<b>labial + apical</b> ↓ <b>labial</b>	<i>birdie</i> <i>water</i> <i>button</i>	[bɔ:bi] [wɔwɔ] [bʌpə]	/bɜdi/ /wɔ:tə/ /bʌtn/	<b>labial + apical</b> ↓ <b>apical</b>	-
	<b>velar + labial</b> ↓ <b>labial</b>	<i>crispies</i> <i>gooseberry</i>	[pipi] [bubi]	/krɪspɪz/ /gu:zbəri/	<b>velar + labial</b> ↓ <b>velar</b>	<i>grandfather</i> [gagə] /græmpa/
	<b>labial + velar</b> ↓ <b>labial</b>	<i>piggy</i> <i>bacon</i>	[pipi] [beɪbən]	/pɪgi/ /beɪkən/	<b>labial + velar</b> ↓ <b>velar</b>	-

Labial is in all but one of the assimilation cases observed the place of articulation towards which the assimilation takes place. Labial assimilates to velar only in the child's realisation of *grandfather* (*grandpa*). Figure 3 presents a subset of the examples presented in Cruttenden (1978:374, Table 1). In total there are four apical+labial examples and twelve labial+apical, there are two velar+labial examples, two labial+velar that assimilate to labial+labial, and one labial+velar that is realised as velar+velar.

With regard to the velars and apicals, in the sequences containing a velar and an apical consonant, the apical consonant assimilates to the velar, rather than *vice versa* (eight cases of the first, one case of the latter, namely *cup-of-tea* [tʌpəti] /kʌpəti/). Cruttenden (1978:375) points to the following three cases as being crucial as they illustrate the strength of velar over apical.

(4)	a.	<i>dog</i>	[kaka]	/dɒg/
	b.	<i>duck</i>	[gɒgi]	/dʌk/
	c.	<i>cuddle</i>	[kʌku]	/kʌdl/

<sup>2</sup> The early prominence of labial is confirmed by the reconstructed phonological development of this child (Lucy); see II10.1 and II9.2.2. This last section discusses Cruttenden (1978).  
<sup>3</sup> 'Vowel descriptions are only very approximate' (Cruttenden 1978:374).

On basis of the above observations in the data presented, and parallel cases in the literature, it is concluded that ‘most assimilations in child language involve deapicalization’ (1978:375). The assimilation processes are reflected in the scale of strength labial > velar > apical.<sup>4</sup>

Whereas a perceptual-acoustic account of segment acquisition can explain the acquisition of apicals before velars, it does not offer an explanation for the assimilation of velar to alveolar, or deapicalisation process (both apicals and velars were present in the child’s system at the time of deapicalisation) (1978:377). The prevalence of velars over apicals in the realisations of the child is explained in terms of production: ‘tip-of-the-tongue articulations [require] more delicate and complex muscular control than back-of-the-tongue articulations’ (1978:378). The reason behind assimilation as such is regarded as psychological in nature, namely inadequate planning of the timing of the various articulations.

### 6.3 Discussion

The explanations offered by the four articles discussed in 6.1 and 6.2.1-3 regarding consonant harmony are:

- |     |   |   |
|-----|---|---|
| (5) | <i>Vihman (1978)</i><br><i>Iverson and Wheeler (1987)</i><br><i>Levelt (1993)</i><br><i>Cruttenden (1978)</i> | <ul style="list-style-type: none"> <li>- feature simplification for storage.</li> <li>- absence of features at the segmental level.</li> <li>- feature changing under influence of vowel.</li> <li>- feature changing through production difficulty because of psychological timing.</li> </ul> |
|-----|---|---|

In the account offered by Iverson and Wheeler (1987), consonant harmony is most clearly a consequence of the developmental state of the child’s phonology, or “immature” phonological system (namely, no specification at the segmental level; see below). However, the explanations in Vihman (1978) and Cruttenden (1978) also link the harmony phenomenon to the child’s development, as the acquisition of further developed skills (for storage and production, respectively) implies the end of consonant harmony. The lack of feature specification at the segmental level proposed in Iverson and Wheeler (1987) for consonant harmony cases points to the absence of a phonological contrast at that level for the segment concerned. Iverson and

<sup>4</sup> This strength hierarchy posits the same prediction as coronal underspecification (cf. II6.1.2), namely that alveolar consonants are most susceptible to assimilation. For a discussion on underspecification and this related claim, see II4..



Wheeler (1987), however, propose a more extreme state of affairs as feature specification for individual segments is not optional in a child's system at the time of consonant harmony. 'Eventually, the child will discover that features ... are distinctive at the segmental level ...' (1987:253) (emphasis mine). This implies that segment specification at the time of harmony is ruled out. This would also rule out that, at the time of consonant harmony, there are also child forms that do not display, for instance, place feature agreement between all segments of the word, or non-harmonic variants of the same target word. This appears to posit a claim that is too strong. Regarding segmental specification, Levelt (1993) offers a VC harmony account that assumes a specification for the vowel. This account does not necessarily predict the same specification across a child utterance (cf. Iverson and Wheeler 1987). It is assumed that at least one adjacent consonant assimilates to the place feature of the vowel, namely  $C_i V_j C_{j/k} \rightarrow C_j V_j C_{j/k}$  (Levelt 1993:38). This points to the assumption that harmony involves features change at the segmental level.<sup>5</sup> For instance, *toren* 'tower' /torə/ ['bowə], where the labial [b] is a "substitute" for target /t/. With regard to this analysis of harmony forms, it is not clear why this phenomenon disappears from the child's data in the course of the phonological or language acquisition; the substitution of place of articulation as an assimilation process does not exhibit any acquisition characteristics.

Besides Levelt (1993), Cruttenden (1978) also envisages harmony as a feature changing process. The motivation for consonant harmony is considered to be the limited planning abilities with regard to the articulations in Cruttenden (1978). As apical articulations are regarded as more demanding from a production point of view than non-apicals, deapicalisation achieves facilitation for the actual articulation of the harmonised word.

The examples presented in Cruttenden (1978) represent the place assimilation cases of one child observed during the eight month period that is studied (1978:374, Table 1). These examples do not appear to be uniform. Firstly, seven out of the total of 30 examples concern consonant

<sup>5</sup> From the reconstruction of the phonological development of this child (Eva, child no. 4; see II1.), it appears that in none of the contrasts discussed here, the feature that is assumed to have changed in the process of vowel-consonant interaction was actually specified (see II3. and II5.). As a consequence, these harmony cases can be regarded as the result of the filling-in of non-contrastive non-specified segment slots.



clusters.<sup>6</sup> Clusters are generally considered to be difficult for the child, and appear to require more developed skills. They do not offer material for comparison with single consonants. Children generally develop various strategies for dealing with consonant clusters (see II7.2). Furthermore, three examples concern [r], either in initial (*rhubarb*, *rabbit*) or in medial position (*gooseberry*). This sound is not yet part of the child's repertoire (1978:373), and an alternative realisation is thus to be expected. In all the cases here, the consonant slot that contains an /r/ in the target word appears to be filled with the place specification of the labial stop in the word. As the full phonological system at the time of these utterances is not presented (see below), this is speculative.

Concerning his subject, Cruttenden (1978:373) states that:

At the onset of [the observation] period her sound system consisted of bilabial, alveolar and velar plosives; the nasals /m/ and /n/; the frictionless continuant /l/; and the fricatives /s/ and /ʃ/. The phonemes /f/, /ŋ/ and /w/ were added during the early part of the period.

Looking at the assimilation processes involving nasals, five target words that contain /n/ in word-medial or final position were all realised with [m] (*man*, *spoon*, *pen*, *(Ri)bena*, *bunnie (sic)*). At first sight, this would seem to suggest that /n/ is not a stable contrastive entity in the child's system yet. However, this not in accordance with the claim that the sound system comprises a bilabial, alveolar and velar plosive, if "consists" means "having a specification for". A similar query arises concerning the plosives; for instance, *duck* [kaka], *dog* [gɔgi], and *cuddle* [kaku]. The statement that '[a]t the time when apicals are being replaced by velars in assimilation in child language, it is usually true that both apicals and velars are present in the child's system' (1978:377) does not provide a decisive answer regarding the question whether the phonetic or the phonological level is referred to by "sound system". Here, it is assumed that in order to make claims about the assimilation processes in a child's words or data, it is essential that the underlying contrasts in the child's system are known. The claims made in Cruttenden (1978) are thus overshadowed considerably by the unclarity about the child's actual phonological system, as well as by the absence of any temporal sequencing with regard to the examples presented.

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<sup>6</sup> The two examples of consonant insertion in initial position, thus attaining a CVCV structure where the target word had a vowel in initial position (*apple* [papa] and *all gone* [gɔgɔn]), are not taken into consideration here (Cruttenden 1978:374).

So, both Levelt (1993) and Cruttenden (1978) seem to propose an account for consonant harmony through feature changing. This, however, only seems to be warranted when it has been established that the changed or replaced feature is indeed a stable member of the phonological system, by making reference to the development of the child's system at the phonological level. The absence of a clear description of the phonological state of affairs in both these proposals, and the reconstructed and seemingly non-confirming information from the articles themselves decrease the ability of these articles to convince. Also, when the explanation of the harmony phenomenon is not based on developmental aspects, e.g. immature production skills (Cruttenden 1978), it does not become clear when and why the phenomenon of feature agreement in the child's utterances ceases. From the discussion of the different proposals concerning the description/explanation of consonant harmony, it can be concluded that that such an account should contain the following element: on basis of the observation that the assimilation phenomenon disappears in the form in which it is present in the output during the earlier stages of phonological development, it is plausible that place assimilation is regarded as a consequence of the child's developmental state of affairs.

Overall, the consonant harmony proposals (reanalysed as VC harmony in Levelt (1993)) discussed here are too unspecific with regard to the child's phonological development (Vihman 1978) or, if it is specific, the claim appears too rigorous (Iverson and Wheeler 1987), and/or the feature changing scenarios are inadequate in the form in which they are presented (Cruttenden 1978, Levelt 1993).

Note that the early acquisition of place is studied in detail on the basis of longitudinal acquisition data in II.5.

## 7. Reduplication and early syllable structure

### 7.1 Definition

Reduplication is 'the repetition of the first syllable [in a child's word], which is usually also the stressed syllable, to constitute the second ... [syllable] in a multisyllabic word' (Grunwell 1982:171). This phenomenon is observed for the child's first words, or the fifty word stage (Ingram 1976:31). Examples of reduplication are (Grunwell 1982:171)):

- |     |    |                 |         |
|-----|----|-----------------|---------|
| (1) | a. | <i>mirror</i>   | [ˈmɪmɪ] |
|     | b. | <i>bottle</i>   | [ˈbɒbɒ] |
|     | c. | <i>umbrella</i> | [ˈdɛdɛ] |

(Note that the initial, unstressed syllable in *umbrella* (1c.) has been not been taken into account in the child's realisation (weak syllable deletion).) Reduplication can be either complete or partial, in the latter case affecting the consonant or the vowel.

The extent to which reduplication occurs in the output of children as has been reported in the literature varies. According to Grunwell (1982:172), reduplication is not an active process for all children, and it is a process that disappears between 2;0-2;6. Berman (1977) concludes that reduplication is a marginal process in the speech of the child she studied (1;6-2). Ferguson, Peizer and Weeks (1973) also discuss reduplication. Their study is based on the data of a child that apparently had adopted a particular strategy (0;11), namely 'the choice of CVCV models and assimilation to full reduplication' (1973:61). Of the three subjects in Stoel-Gammon and Cooper (1984:268), one child produced a reduplicated CVCV pattern frequently (11;2-1;7.0).

Both Ferguson *et al.* (1973) and Berman (1977) discuss the extent to which reduplicated forms occurring in the language that the child is learning as a relevant factor. Berman's (1977) subject was acquiring Hebrew, and a number of the reduplicated forms produced by the child were not a deviation from the adult words; they reflected nursery usage in general (1977:7). Ferguson *et al.* (1973) mention 'normal adult language' and nursery talk, and the occurrence of reduplication therein, as well. They also state that '[f]or English children not exposed to extensive baby talk some investigators have the impression that the predominance of reduplication marks the "slow learner" of phonology' (1973:62). The child's strong preference for reduplication is thus concluded to probably be related to her overall slow phonological development (1973:64). The

relation between reduplication and “slow learners”, however, is not confirmed in studies on the motivation into reduplication (see 7.2).

## 7.2 Motivation of reduplication

### 7.2.1 *Limited abilities and final consonant production*

With regard to the motivation behind reduplication in child realisations, reduplication is regarded in Klein (1978) as a syllable maintaining process, occurring early in the acquisition, ‘reflecting perceptual ... and motor ... constraints on phonetic contrasts and complexity’ (1978:96). According to Waterson (1970:5), the initial forms produced by the child are monosyllables and reduplicated forms. Regarding the change from monosyllables to di/multi-syllables, the child uses what is familiar in his attempt to produce a form outside his repertoire in order to reduce the number of contrasts (i.e. the number of new, non-repertoire features) (Waterson 1987:16). According to her, the production of a word of more than one syllable involves ‘the perception and reproduction of the features of the accented syllable and an unclear impression of the second syllable, with a gradual adjustment of features until a more fully differentiated second syllable is achieved’ (Waterson 1970:8; cf. Moskowitz 1971:71-72). So, limited perception and a limited capacity to produce a number of contrasts are aspects reflected in reduplication.

Ingram also offers possible motivations/speculations concerning reduplication. His “early” view agrees with Waterson (1970), as repetition of the initial syllable is regarded as a compensation for the child’s inability to represent or reproduce the second syllable in the target word (Ingram 1974a:54). With regard to the status of the second syllable, no morphological value should be ascribed to it; it merely is an attempt to represent syllabic noise (1974a:54) (cf. 4.1). The CV contents of the second syllable are predictable and hence not contrastive (Ingram 1976:64). In reduplication, ‘the production of a second syllable is simplified by repeating the first’ (1976:29). The motivation for reduplication is suggested to be related to final consonants and the child’s ability to produce them; ‘[i]f a child has difficulty [to produce final consonants], the use of some partial reduplication can assist in this, e.g. *dog* [da] or [daga]’ (1976:31). Indeed, some children acquire post-vocalic consonants through reduplication (Ingram 1986:231). Ingram (1978:141-42) states that there are at least three phonological reasons for reduplication: i) to match a polysyllabic adult pattern, ii) to allow production of the final consonant of the adult target, and iii)

the child's preference for a particular pattern. The first two of these claims are investigated in an extensive study on reduplication by Schwartz, Leonard, Wilcox and Folger (1980), the results of which are discussed in Fee and Ingram (1982) (7.2.2).

### 7.2.2 *Schwartz et al. (1980), and Fee and Ingram (1982)*

*Schwartz et al. (1980)* aim at examining the phenomenon of reduplication in terms of the following aspects (1980:77):

- i) the relationship between the extent of reduplicated forms in a child's output and that child's overall abilities to produce attempted multisyllabic forms and forms with final consonants.
- ii) the role of the process of reduplication in production constraints; when reduplicators apply the process of reduplication (i.e. produce an attempted word as a reduplication), what are the characteristics of the target word (i.e. word to which it is applied) and what is the result?

These criteria are related to Ingram's suggestions that i) reduplication may be a way of compensating for the child's inability to represent (or produce) the second syllable of a word appropriately, indicating a limited variety in the child's lexical forms and ii) reduplication may reflect difficulty in final consonant production (1980:76) (see 7.2.1).

Twelve children participated in the Schwartz *et al.* (1980) study (between 1;3 to 1;10). Children of whom at least 20% of the sampled lexicon (i.e. spontaneous utterances) consisted of fully (e.g. C<sub>1</sub>V<sub>1</sub>C<sub>1</sub>V<sub>1</sub>) and/or partially reduplicated forms (e.g. C<sub>1</sub>V<sub>1</sub>C<sub>1</sub>V<sub>2</sub>, C<sub>1</sub>V<sub>1</sub>C<sub>2</sub>V<sub>1</sub>) are regarded as being "reduplicators" (1980:77-79). The conclusions of the study are as follows:

'... a stronger relationship exists between constraints upon the production of attempted nonreduplicated multisyllabic forms and the adoption of a reduplication strategy than between the adoption of this strategy and constraints upon final consonant production' (1980:83).

'... reduplication served more frequently to constrain the production of multisyllabic rather than monosyllabic forms' (1980:83).

'... reduplication served more frequently to constrain the production of multisyllabic forms [than to constrain final consonant production]' (1980:84).

'... reduplication was a process that was applied primarily to multisyllabic forms and thus served primarily to constrain the production of such forms' (1980:84).

From the findings that reduplication was more closely related to multisyllabic forms than to monosyllabic forms and final consonant production, the possibility of another factor was raised 'which served to constrain the production of final consonants in the phonologies of the reduplicators [and non-reduplicators]' (1980:84). For both groups of children, reduplicators and non-reduplicators, an additional factor was found in the process of final consonant deletion.

Significantly greater constraints on final consonant production were observed for reduplicators, however, and in this context, the notion of *conspiracies* is introduced (after Kisseberth 1970):

the relatedness of phonological rules may not lie solely in similarities of structure or the segments on which they apply. Instead, the relatedness of such rules may depend largely upon similarities in their function or effect. Rules which are related in this way may be said to "conspire" to a particular result (Schwartz *et al.* 1980:85).

This also raises the spectre of rule ordering. For instance, if final consonant deletion does not precede reduplication, then *cup* might appear as CVCCVC, rather than CVCV.<sup>1</sup> Similarly, syllable deletion is assumed to conspire with reduplication in the phonologies of reduplicators to simplify syllable structure and/or final consonant production (for example, *broken* did not appear as CVCV(C)CVCV(C), rather it was realised as [bobo]).

In conclusion, reduplicators were more constrained in their production of multisyllabic forms and to a lesser extent of final consonants than non-reduplicators. For reduplicators, reduplication served primarily to constrain the production of multisyllabic forms. It may have conspired with final consonant deletion and syllable deletion to constrain the production of final consonants (1980:86).

Fee and Ingram (1982) set out to explore the role of reduplication and the question whether this process is a distinct strategy of acquisition or a general pattern. Their conclusion is that reduplication appears to be 'a general feature available to children in their earliest attempts at multisyllabic productions' (1982:53), to master structural complexity.

The findings in Fee and Ingram (1982) support those in Schwartz *et al.* (1980). The interpretation by Fee and Ingram (1982) of one of the findings is different though. The difference in the proportion of non-reduplicated multisyllabic forms between reduplicators and non-reduplicators - a smaller proportion for reduplicators - is attributed to the fact that reduplicators are more constrained in their production of multisyllabic targets in Schwartz *et al.* (1980:49). However, the Fee and Ingram (1982) study also found that reduplicators use fewer monosyllabic forms, and hence a larger proportion of multisyllables. This is regarded as not being compatible with the conclusion in Schwartz *et al.* (1980). It is suggested that the reduplicators do not essentially have

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<sup>1</sup> Reduplication of  $C_1VC_2 \rightarrow C_1VC_1VC_2$  is reported in Ingram (1974a:56) (data from Roussey 1899-1900). Schwartz *et al.* (1980:85) state that 'reduplications in this form have only rarely been reported in the literature'.



greater difficulty in reproducing multisyllable words than other children (why indeed would they produce more multisyllabic forms than present in the target language). Rather, 'they are at the onset of phonological development and are concentrating on developing multisyllabic rather than monosyllabic productions' (Fee and Ingram 1982:52).

So, some children, i.e. reduplicators, will concentrate on producing CVCV forms, while others will focus on the final consonant in CVC production. Reduplicators have not yet begun the development of final consonants. Reduplication is therefore assumed to precede final consonant production.

### 7.3 Summary

Reduplication is the production of a syllable followed by another syllable that is (partially) similar to the first. It is a strategy used by some, but not all, children to different extents (7.1). For example, in Klein's (1978:96) study, one child clearly adopted reduplication in his developmental repertoire. Joshua's reduplication strategy was

- (1) organizationally selective in applying to words beginning with a consonant (words beginning with a vowel were generally reduced ... , (2) perceptually selective in that the consonant in the stressed syllable(s) was retained, and (3) productively predictable in that the CVCV(CV) (CV) pattern was consistently produced.

Reduplication reflects the child's limited perceptual and production abilities. Its motivation is suggested to relate to the child's difficulty to produce final consonants (7.2.1). (The suggestion that it characterises the output of slow learners is not confirmed by studies into reduplication.) Two studies on the reduplication strategy in early child language (Schwartz *et al.* 1980, and Fee and Ingram 1982) conclude that reduplication enables the child to produce a bi/multi-syllabic word (cf. Waterson 1970, see 7.1). It also constrains the production of final consonants. The explanation for reduplication given in Fee and Ingram (1982) is related to the focus of the child's attention, on CVCV rather than CVC forms. Schwartz *et al.* (1980) assume that reduplication, together with final consonant deletion and syllable deletion, conspires to impose a constraint on the production of non-reduplicated multisyllabic forms and final consonants. This conspiracy idea raises the spectre of rule ordering (deletion process precedes reduplication). Rather than positing conspiring processes to prevent "complex" forms from being realised, this view appears to be better turned round: reduplication is the best the child can manage. Reduplication is better regarded as a reflection of the limited abilities of the child and his structure that is only partially ready to produce words exceeding the CV pattern. This is confirmed by its early occurrence in the



acquisition process. In this respect, reduplication is comparable to wordpatterns, the former a general and the latter a word specific pattern. Reduplication gradually disappears from the child's output as his production and perception abilities develop. So, to explain reduplication as an individual child's concentration on CVCV structure appears plausible (Fee and Ingram 1982), and makes sense from a cognitive point of view.

In II, the early acquisition data of five Dutch children and two English children are studied. The reduplicated forms in their output are discussed in II9..

II DATA: MATERIAL, METHOD, AND DISCUSSION

1. Material and method

1.1 **Requirements of the data**

The basis for the investigation into early segment representation here is the development of a child's phonological system. In order to establish this evolution, a set of data of a number of children is required that is recorded regularly over a certain period, and that is complete 'in the sense of all forms produced during regular visits (in the case of outside investigators reporting the data), or all forms recorded over the period in question (in the case of a diarist observer)' (Vihman 1978:283).

A further requirement of the data is that the period of language production observed comprises the early stages of the stratification of the child's phonological system, i.e. includes the final stages of the pre-speech period. During the child's pre-speech period, babbling is the dominant activity. In the babbling period, 'auditory feedback and kinaesthetic memory are used to establish articulatory habits' (Waterson 1987:64 after Fry 1966). This takes place at a time when the spatial co-ordinates of the vocal tract as well as the discriminatory capacity of the articulators are changing as part of the child's physical maturation (Stark 1986:167). Towards the end of the babbling period, divergence of the universal babbling phenomenon occurs when selective, language-specific phonetic acquisition is observed (1986:153). This is also referred to as "protolanguage", i.e. 'a limited set of simple functional vocalizations supplemented by gestures and used in relation to the context' (Waterson 1987:118 after Halliday 1975). This protolanguage is reported to occur around 8 months. This coincides with the onset of the non-reduplicated babbling period in Stark (1986). The stages of vocal development proposed in Stark (1986:156-62) are given below. (These stages overlap considerably, in that, for instance, the characteristic vocal behaviour from early stages only gradually become less frequent as new stages emerge.)

(1) stage I	0-8 weeks	<i>reflexive crying</i> - predominantly voiced, egressive and vowel like; and <i>vegetative sounds</i> - equally likely to be voiced or voiceless, egressive or ingressive, vowel-like or consonant-like).
stage II	8-20 weeks	<i>cooing sounds</i> - produced in comfortable states, vowel-like with consonantal elements; and <i>laughter</i> .

stage III	16-30 weeks	<i>vocal play</i> - longer series of sounds compared to the cooing stage, including vowel- or consonant-like steady states, features present stage i. and ii. are used repeatedly, prolonged and elaborated; moreover, these are used in communicative situations.
stage IV	25-50 weeks	<i>reduplicated babbling</i> - series of CV syllables are produced in which the consonant is the same in every syllable.
stage V	9-18 months	<i>non-reduplicated babbling</i> - V, VC and CVC syllables occur within a series; both consonants and vowels may differ within a series.
stage VI		<i>production of first words.</i>

The protolanguage is regarded as the first linguistically functional phonological pattern in the language acquisition process of the child (Waterson 1987:118). 'Some infants spend several months in this activity [i.e. non-reduplicated babbling]; others proceed more rapidly to Stage VI, the production of first words' (Stark 1986:162). The child's first words are regarded as a continuation of the protolanguage. They are analysed in order to establish the oppositions that constitutes the child's phonological system (see 1.3). First words are assumed to arise around 12 and 18 months (Macken 1992:674). Longitudinal data observation should start between 1 and 1½ years (cf. 3.).

A major data source was recognised in the database with child language utterances that was created as part of a project carried out in the Department of General Linguistics, Rijksuniversiteit Leiden/Holland Institute of Linguistics in the Netherlands.<sup>1</sup> The data was made available to me through H. van der Hulst (project leader). The two researchers that collected and transcribed the data, P. Fikkert and C. Levelt, completed theses on the acquisition of prosodic structure, and place of articulation, respectively (Fikkert 1994, and Levelt 1994).

Levelt (1994) comments on the availability of appropriate data: 'Solid child language data that are specifically apt for use in phonological studies are not easily attainable' (1994:2). Paschall and Irwin (1983), in their review of literature on phoneme acquisition research, observe that there is a lack of data from children younger than three years. This is 'unfortunate, for even a cursory examination of child language literature shows that important phonological gains occur during

<sup>1</sup> This data(base) will be referred to as the ChildPhon data(base) (see 1.3.2).

these early months of life' (1983:4). Indeed, the lack of appropriate data became apparent when searching for additional longitudinal data (cf. MacWhinney 1991). Diachronic data for English that satisfied the requirements was found through Cruttenden (1978), namely diary recordings of his two daughters. Both the Cruttenden and the ChildPhon corpus are discussed in detail in 1.2 and 1.3.2. below.

## 1.2. Data description

### 1.2.1 *ChildPhon database*

The child language data in the ChildPhon database are longitudinal, naturalistic speech samples from 12 children. Recordings were made at the children's home during 'natural, spontaneous, interactive sessions' (Fikkert 1994:24) during which one observer interacted with the child, for instance, by means of playing with toys or reading books. Occasionally, observations were structured in that the child would be asked what he saw in a book or what he was doing. Recording sessions lasted between 30-45 minutes, and were conducted every fortnight for a period of 7-15 months. The recordings of the child utterances were phonetically transcribed (narrow IPA transcription), independently by two people, and subsequently they were compared.<sup>2</sup> Only those utterances on which agreement was reached were included in the database (1994:24-28).

The 12 children (six male, six female) that were recorded fortnightly were all monolingual, acquiring standard Dutch in families that are described as middle-class (Levelt 1994:7).<sup>3</sup> The ages of the children at the beginning of the recording sessions were between 1;0.10 and 1;11.8. Six children were from Leiden (in the West of the Netherlands), and six children were from Groningen (north-east Netherlands). This difference is not considered to have affected the two groups (Fikkert 1994:24-27).<sup>4</sup>

<sup>2</sup> Note Scobbie, Gibbon, Hardcastle and Fletcher (1996) and the discussion on covert contrast in the acquisition of phonology (among other things), which discusses a claimed limitation on the approach to data transcription reported in III.2.1.. 'Covert contrast occurs when the child succeeds in acquiring an immature, inappropriate or deviant contrast in such a way that the contrast is not perceivable by its speech community' (1996:3). Instrumental analysis is considered to be able to expose these unperceived or unperceivable contrasts which impressionistic phonetics cannot.

<sup>3</sup> '[T]he children form a homogeneous group, since all children are from families in which at least one of the parents had an academic degree' (Fikkert 1994:26).

<sup>4</sup> Note Faingold (1997) concerning the suitability of (some of) these subjects. It is suggested that the total absence of final consonants in the data of the older children in the ChildPhon database (age at beginning of the observation period between 1;7.14 and 1;11.8) could be the result of chronic ear infections (conductive or sensorineural) (1997:294). Indeed, Levelt (1994) states that no tests were

Regarding the choice of data from the ChildPhon database (see Fikkert 1994:27, Figure 1), the development of three children had already progressed too much at the beginning of the recording to comprise the early stages of phonological development (Enzo, David, Leon). The data from Robin, Jarmo, Elke and Eva is said to be “systematic” with respect to the phonological development and, also, the development at the time of recording was still in its initial stages. Noortje’s data had not sufficiently differentiated for it to clearly reflect phonological development (Paula Fikkert, personal communication).

On basis of this preliminary information concerning the data of individual children, and the age requirements (see 1.1), five data sets were selected for analysis here:

(2)	<i>Robin</i>	1;5.11	-	2;4.28	male	child no. 2
	<i>Eva</i>	1;4.12	-	1;11.8	female	child no. 4
	<i>Tom</i>	1;0.10	-	2;2.2	male	child no. 7
	<i>Jarmo</i>	1;4.18	-	2;4.1	male	child no. 8
	<i>Elke</i>	1;6.4	-	2;4.29	female	child no. 9

So, the ages of the five Dutch children selected at the start of the observations were between 1;0.10-1;6.4, and at the end of the observation period between 1;11.8-2;4.29.<sup>5</sup>

### 1.2.2 *Cruttenden corpus*

The utterances of two girls, Lucy and Jane, were collected by their father in their home situation, for instance, during play sessions (A. Cruttenden, personal communication). The data can thus be said to be naturalistic. The children, dizygotic twins, were acquiring British English. The diary recordings were made between the ages 1;5.17 and 2;5.16, with intervals between 1-14 days (with the exception of one instance of 36 days). The average time between observations is 6.7 days for Lucy, and 6.8 days for Jane. During the third and fourth month of this period, the children were away from home, and no recordings were undertaken. The first month of recording coincided with the onset of the two-word stage. The data from Jane and Lucy will be distinguished by means of different capital letters; **J** and **L**, respectively.

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conducted; ‘The children all appeared to have a normal hearing acuity and normal cognitive and motor development’ (1994:7).

<sup>5</sup> The child numbers refer to the identification numbers of the children in the database (see 1.3.2), and will be used in the discussion here (in bold format).

### 1.3 Method

In this section, the structure of the databases is discussed (1.3.2), as well as the different stages of preparing the data (1.3.3) and the reconstruction of the phonological system on basis of the utterances from each child selected (1.3.4). First, however, two clinically based proposals regarding phonological analysis are briefly reviewed, namely Grunwell (1987) and Ingram (1981) (1.3.1). The aspects of their proposals that refer to the reconstruction of a child's phonological system will be relevant to the discussion of the method of processing the child language data applied here.

#### 1.3.1 *Phonological analysis*

Grunwell (1987) emphasises the cognitive aspect of phonological development, and the functionality of segments, whilst recognising the autonomy of the child's phonological system (see below). On the basis of this, it appears to be an attractive source to take into account when analysing the child language data.

... the fundamental premise of the phonological therapy must surely be that the changes in speech production need to take place not so much in the mouth but in the mind of the child. The aim of treatment is to effect cognitive reorganisation rather than articulatory retraining (1987:280 after Grunwell 1983).

... phonological knowledge is fundamentally knowledge of the organisation and function of the system of sound contrasts which signal sound contrasts (Grunwell 1987:280)

For the analysis of a child's phonological system, the following three components are required according to Grunwell (1987:92):

- i. a statement of the sets of contrastive phones at each place in the structure together with details of the non-contrastive variants of each contrastive phone.
- ii. a statement of the feature compositions of the contrastive phonemes.
- iii. a statement of the phonotactic possibilities.

As (one of) the goals of the research here is to investigate which notational framework expresses the child's early phonological development most insightfully (see III), the oppositions decided on, on basis of i., will be expressed here in terms of descriptively more general contrastive entities rather than specific features. With regard to the third aspect, the analysis here will concentrate on the segmental development on basis of single consonants. CV structure and clusters will only be considered when relevant to the realisation of single consonants.



The notion of contrast in child language data is notoriously difficult. Grunwell (1987) discusses the notions of neutralisation, free variation and overlapping, which could be helpful in determining the identity of the contrastive entities in the child's system at a given time. They also require the data to be presented with a focus on the target word. A (alphabetical) list of the child's utterances would make it possible to investigate this. The notions are defined as follows (1987:99):

- neutralisation*      where a contrast established at one position in the structure does not operate at another position in the structure.
- free variation*      where a pair of phonetically different phones occur at the same position in structure in repeated pronunciations of a substantial number of words; in such circumstances these phones cannot be established as contrastive and are analysed as variants of one contrastive phone.
- overlapping*        when a pair of established contrastive phones are used at the same position in the structure in the pronunciation of the same word on two separate occasions. '[The members of this pair] are to be regarded as remaining distinct even if there is variability ...' (1987:96).

On a more general level, it is noted that (1987:96):

Where there is no positive evidence to indicate that a phone is a non-contrastive variant, then it should be analysed as a contrastive phone. In other words, every phonetically different segment should be regarded as potentially contrastive unless there are clearly storable grounds for including it as a variant of an already identified contrastive phone.

The phonological analysis proposed in Ingram (1981) is also based on clinical experience, and comprises four parts:

- i.    *phonetic analysis*      the goal of phonetic analysis is to establish the child's phonetic inventories for word initial, medial and final position, and the frequency of preferred syllable shapes (1981:23).
- ii.   *analysis of homonymy*   the goal of the analysis of homonymy is to establish the extent of homonymy in a child's speech by the use of a measure that gives a) homonymous words, and b) homonymous phonetic forms (1981:7).



- iii. *substitution analysis* the goal of substitution analysis is to determine the substitutions used by the child in his or her attempts to produce the initial, final, and ambisyllabic consonants and clusters of the adult language (1981:57).
- iv. *phonological process analysis* the goal of phonological process analysis is to describe a child's initial, final and ambisyllabic substitutions by a finite set of phonological processes, and to determine the extent to which each process occurs (1981:77).

With regard to the notion of frequency in phonetic analysis (see i. above), Ingram (1981:4) notes the following:

Because transcription error is always a possibility, the inclusion of a minimum frequency criterion allows analysts to minimize this. Also, I decided that because children use preferred sounds, more frequent sounds have a special status that needs to be taken into account. ... for a sound to meet a minimum frequency criterion, it will need to occur in a certain number of words and phonetic forms.

Without going into the motivation and/or validity of the above statements,<sup>6</sup> I will now consider the use of the frequency criterion and calculations in the Ingram proposal, keeping the phonetic analysis (i.) as the main focus. It appears that interpretation of the various outcomes is mainly used for comparing the development of one group with another, e.g. normal and language-delayed children (1981:97-99). Statements like 'data show no evidence of general use of [j], and they show the later acquisition of [f] [s] as well as the earlier use of [k] and [g]' are not considered intrinsically relevant to the approach envisaged here. The construction of inventories in Ingram (1981) is claimed to result in 'a representative inventory of sounds that can be used for comparative purposes to determine an individual child's stage of acquisition' (1981:99). This method is thus specifically suitable for comparison and for a remedial approach. Neither objective is relevant to the research outlined here.

The aspect of homonymy (ii.) is not of direct interest to the reconstruction of the child's early phonological development. Where homonymy provides information about the child's (lack of)

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<sup>6</sup> And not being able to evaluate statements like '... based on the arbitrary statement that any sound used by the child should at least occur once in any random selection of 25 phonetic forms or lexical types' (Ingram 1981:26).

discrimination of adult sounds, it will be taken into account. The undesirability of phonological processes (iv.) has been discussed in I4.1. They are simplification devices that assume the presence of an adult-based representation in the child's lexicon. The assumption that more structure is present underlyingly than can be directly observed from the child's output is also related to the substitution analysis discussed below.

Ingram (1981) also discusses a method to determine what is substituted for what (iii.), that is, which child phoneme is substituted for which adult phoneme. "Substitution" implies that both the substitution and the substitute are available to the child (Grunwell 1987:64). Substitutions are relevant to the extent that they are an indication of what the child hears when perceiving an adult word, concluded on basis of the child's output.

An important difference between Ingram (1981) and Grunwell (1987) is the approach they take concerning the output of the child, and its relation to the adult output and the structure of the adult phonological system. Ingram (1981) adopts the notion and practice of phonological processes (see above). Grunwell (1987) focuses more on the child's output and the analysis proposed by her 'attempts to establish and describe the child's pronunciation system independently of the adult target system' (1987:91). This approach is favoured here as it acknowledges the autonomy of the child's phonological system, amongst other things.

So, in order to establish a child's phonological system at a particular time, the inventory of phones in the child's output at a given time, as well as the development of the pronunciation of individual words are regarded as essential sources of information. In practical terms, the basic data required to study early phonological development is:

- A. the inventory of the child's phones at the different recording sessions. Per child, per session, all different phones need to be counted, making a distinction between initial, medial and final position, and entering the discrepancies between target and child phones.
- B. an alphabetical list of the child's utterances, ordered according to recording session and the order in which they were produced within one session, to study the development of and/or variation in the pronunciation of a particular target word.

The following section discusses how the basic material in this format was obtained from the two data sources, taking into account the way the two databases, ChildPhon and Cruttenden, are structured.

### 1.3.2 *Structure databases*

The data in the ChildPhon database is structured around three different files, namely Child, Adult and Utterance files. The Child file contains information on the subjects (child number, name, date of birth<sup>7</sup> and nationality.<sup>8,9</sup> The Adult file contains the orthography of an adult utterance, its broad transcription, CV structure, morphological information and translation into English.<sup>10,11</sup> The different files are interlinked by means of a particular field. The Child file is linked to the Utterance file through the field for child number, and the Utterance file is linked to the Adult file through the field for orthography (following Levelt 1994:10). The other fields in the Utterance file, besides child number and orthography, contain information regarding the day of observation, the narrow transcription of the utterance (phonchild), the sequence number of the utterance in the case of several realisations of the same target word during one observation session (child sequence number), the CV structure of the child utterance, whether the utterance was spontaneous or imitated, and an indication of observed phenomena (comparable to phonological processes, cf. Fikkert 1994:30) in the utterance. The basic structure for the database is presented below. For more information, see Fikkert (1994) and Levelt (1994).

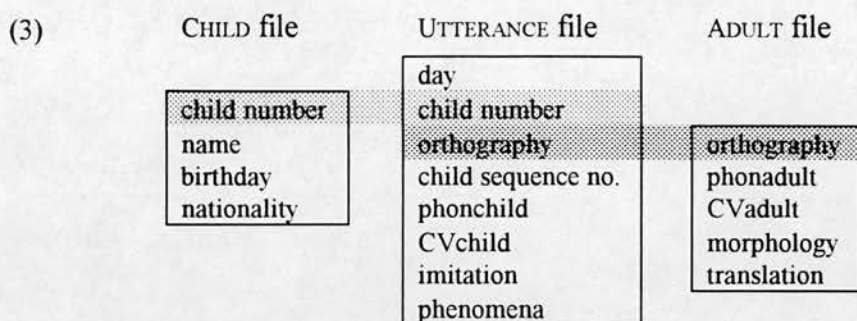
<sup>7</sup> Date of birth is presented in the field entitled birthday.

<sup>8</sup> The nationality entry is presumably meant to reflect the language the children were learning, rather than their citizenship. Indeed, a hard copy of the Child file has the heading "Language" for this field.

<sup>9</sup> According to Levelt (1994:10), the Child file also has a field for additional comments.

<sup>10</sup> In Fikkert (1994:29), it is stated that the Adult file also contains an Adult Sequence Number 'which is the unique number for each adult target', whereas the Child file contains the same field 'which relates the utterances [of the child] to the Adult file'. In Levelt (1994:10) and the ChildPhon manual (1994), the Orthography field which occurs both in the Adult and in the Utterance file is responsible for the relation between Utterance and Adult file. This difference is not considered relevant to the use of the database here.

<sup>11</sup> According to Levelt (1994:10), the Adult file also contains a field for the Number of Syllables of Adult utterance.



ChildPhon (Child Phonology) is a database system (AppleMac) that is developed at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. ChildPhon requires the database software 4th Dimension (version 2.0). The font used to print the IPA transcription in the basic material used in the research here was IPATimes (Fikkert 1994:28-29, ChildPhon manual 1994:2-3).

Strictly speaking, ChildPhon refers to the database as such, and not necessarily to the Dutch child language data, collected by P. Fikkert and C. Levelt, entered therein. However, here ChildPhon will be used to refer this data, and more particularly, to the selected data of the five children discussed above: Robin (2), Eva (4), Tom (7), Jarmo (8) and Elke (9).

Compound searches were formulated for the data of each of the five children selected to retrieve all instances of a particular phone from all the spontaneous utterances in their output.<sup>12</sup> The child number and imitation field were specified (e.g. child number=7 and imitation=s(pontaneous)) in the search editor, and subsequently a phone was specified in the execute procedure, that allowed searches for IPA characters (see ChildPhon manual 1994). Searches were executed for all phones specified on the output sheet, on which the results of these searches were logged (see 1.3.3). The outcome of the searches was printed in columns: child number, day, child sequence number,

<sup>12</sup> Utterances of which the orthography was marked with a question mark were not taken into account. It appears to indicate interrogatives (*doen ze daar nou?* '(what) do they do there?' 2 #19, *waar is caravan* 'where is caravan?' 2 #14). However, utterances that would be interpreted as a question, e.g. *wat doen ze daar nou* 'what do they do there' 2 #14, *waar heb ik pijn* 'where do I hurt' 2 #22, do not have a question mark, whereas *koffer?* 'suitcase' 4 #14, *school?* 'school' 4 #3, and *wassen?* 'to wash' 4 #4, for example, do. As the significance of the question mark in the orthography field was not clear, and the overall number of utterances marked in this way was limited, these were not included in the data processing.

orthography, phonchild, and phonadult. The output was sorted (ascending) according to day of observation and child sequence number (secondary search command). This thus provided the basic material described under A. above (1.3.1).

All spontaneous utterances of each child were also selected and sorted according to orthography, resulting in an alphabetical list of the child's target words (providing B.). In the cases of more than one realisation of an adult target (i.e. orthography), the childphon for earlier days is presented before later days, and secondary to this, the earlier utterances of one recording session (i.e. day) are presented before later utterances. In the discussion of the data, the recording sessions of specific days will be referred to as numbered sessions, e.g. #12. The relation between recording dates and session numbers is presented in Appendix A.

The format of the Cruttenden corpus is straightforward. The utterances of one child for each month of observation are placed in a separate file, under the heading of the day of observation. Each utterance is presented in a separate paragraph containing three lines: target word, transcription of utterance and comments. To achieve a similar format of basic material as for the ChildPhon data, a data file was created for each child (Word for Windows) with columns for the child identification letter (J or L), date of observation, target word, and phonetic transcription of the child utterance. Utterances which were indicated to be repeated, rather than spontaneous, or about which there appeared to be uncertainty on basis of data entry (e.g. question mark between brackets, angular brackets around utterance or transcription) were not taken into account. For each child, an alphabetical list of target words was prepared as well.

The Cruttenden data was taken from the CD-ROM 'The CHILDES Database' (February 1996), provided by B. MacWhinney. Application of the recommended IPAPhon font (AppleMac) resulted in some non-IPA symbols in the transcription of the child utterances. Application of the original font, PalPhonMac (PC), resulted in an proper transcription.<sup>13</sup>

For the analysis of the utterances of the two English children the (observations from) different dates were divided in periods that span (approximately) two weeks (see Appendix A). These "recording sessions" are similar to the observation intervals of the ChildPhon data. This timespan

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<sup>13</sup> Available on the internet: <http://umich.Mirror.McGill.CA/system.extensions/font/type1/palphon.cpt.hqx> (November 1997).



is regarded as appropriate for longitudinal observation as it makes it possible for the child's phonological system to develop to such an extent that change is observable on basis of the child's output. Longer intervals make it (more) likely that changes can not be observed as the system has developed through more than one change (cf. Fikkert 1994:26-27). The analysis of the English data is based on the utterances from these "sessions".

### 1.3.3 *Processing of data*

Once the basic material had been prepared, the data was counted, and the result was registered on output sheets. For each session for each child, the different phones for the three syllable positions (initial, medial and final) were calculated. Single, consonantal phones were taken into consideration, rather than clusters and/or vowels. In the case where the child realisation of the target phone was different from that target, the target phone was also entered. When different child phones were observed during the processing of the data from those on the output sheet, they were included on the output sheet as well. For the ChildPhon data, the outcome of the searches, which are specified for a particular phone, corresponds to the realisations that are relevant for the phone count of that specific phone. The Cruttenden data was not ordered in such a way, and the chronological list of utterances was used for the phone counts. The form of the output sheet is based on the method of practical analysis discussed in Grunwell (1985). The output sheet is presented in Appendix B. The information on the output sheet for one observation session is the basis for determining the phonological system at that time of observation. The evolution of the child's phonological system is deducted from the successive phonological systems and the way they interrelate.

### 1.3.4 *Reconstruction of phonological system*

In order to establish the phonological system of a child on basis of the data from one observation session, the "stable" and "unstable" realisations of the child were studied. Words, or phones, that are realised similar to the target word, and are consistently produced so, i.e. all later realisations of the same target word are also similar to the target word, are regarded as stable; the child has mastered the pronunciation of the target word. Realisations that are not similar to the target word have not (yet) stabilised, hence they are considered unstable forms. The relation between the realised phones and the target phones is evident from the output sheet, which provides an indication which target sounds the child has mastered and which sounds are still unstable, i.e. in

free variation in the child’s output. Analysis of the words in which these unstable phones occur, in particular, the development of the pronunciation of these words, provides information about the change in status from unstable to stable. The evolution of a contrast can thus be determined on basis of the phone counts of successive observation sessions, and, in addition, the diachronic development of the realisation of particular target words. Several aspects that have been taken into account when deciding which contrasts are posited for the child’s phonological system are discussed below. Once the contrastive entities have been established for each session, the stages of the evolution of the child’s phonological systems were determined

With regard to the distribution of a particular phone over the three syllable positions, Grunwell (1987) proposes a polysystemic analysis and the analysis of contrastivity for each place in the structure. However, as the purpose for the phonological analysis here is not remedial, one system of contrasts will be constructed from the information on phone distribution in initial, medial and final syllable position. For a phone with limited occurrence, phoneme status is only assumed when it occurs in more than one syllable position. (Exceptions to this criterion are segments of which the distribution is restricted to one or two of the three position distinguished here, e.g. /h ɲ/.)

In a situation where a phone is observed to be stable in one (set of) word(s), and to be in free variation in another, the determination of contrastive status is not straightforward, as illustrated by (the interaction of) [k] and /k/ below.

(4) Utterances Robin 2 #9

<i>boek</i>	/buk/	‘book’	[puk ‘buχ ‘buk ‘pukä ‘boik]
<i>broek</i>	/bru:k/	‘pair of trousers’	[‘buk]
<i>kaas</i>	/kas/	‘cheese’	[‘kaʃ]
<i>kikker</i>	/kikəɪ/	‘frog’	[‘titä ‘fi:p ‘tit]
<i>kip</i>	/kip/	‘chicken’	[‘?it]
<i>koe</i>	/ku/	‘cow’	[‘ku ‘kʏ]
<i>konijn</i>	/koˈneim/	‘rabbit’	[nein ‘neɪn ‘ke]
<i>uit</i>	/œyt/	‘out’	[ʔaut ʔaʔ ʔœyt ʔek ʔœyt ʔoit]

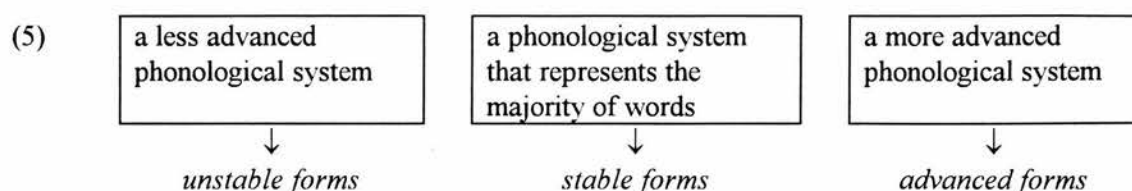
The child’s system is in a state of change as his capacity to perceive, produce and phonologically represent words increases during the early stages of language acquisition. Generally, the child masters different words at different times. They can thus be said to develop at different rates, not necessarily parallel to one another. This ties in with the phonetic parameter discussed in Ferguson



and Farwell (1975) in relation to sound change and the determination of phonological contrast. They adopt Wang's (1969) model of phonetic change:

... the phonetic manifestation of a sound change occurs abruptly at some point, goes through a period of variation in which some words are found in two forms, and finally approaches completion ... (Ferguson and Farwell 1975:430 after Wang 1969).

It is possible to envisage that each word or group of words is produced according to its own state of development as part of a continuous process towards a more adult-like realisation. An abstraction and simplification of this at any time would be a model with (three or  $n$ ) different phonological (sub-)systems:



These three systems co-exist. Stable forms, reflecting a certain (state of) phonological development, are realised at the same time, i.e. recorded in one observation session, as more and less developmentally, phonologically advanced forms. Unstable words would comprise, for example, first instances of words and realisations that remain exceptionally irregular. The three systems, or  $n$ -systems for that matter, are a continuation of each other, in that unstable forms will become stable, and the majority system will comprise more stable words, thereby redefining itself in terms of the phonological state of affair of the previous advanced system. They reflect the change in the child's system within the context of its evolution. In adult language, a situation in which all forms produced are not reconcilable under one system would reflect change as well (personal communication John Anderson). In this respect, child language and adult language are not regarded as different.

Under this philosophy of change, "the phonological system of a child" is regarded as being the consensus system underlying the child's realisations. This is also part of Grunwell's (1985) proposal, where the difference between contrastive and non-contrastive status is determined by the relative number of occurrences of variable and stable forms (1985:37-38). In practical terms, this means that the free variation, as apparent from the discrepancy between realised phones and target phones registered on the output sheet, and the diachronic development of all relevant words are

taken into account in order to determine which contrasts are present in the child’s phonological system.

1.4 Statistics

In this section, the application of statistics is considered in relation to the research here. Different types of statistical methods are discussed, namely descriptive and inferential statistics, as well as the application of these methods to the data of the study discussed in 1.3 above. Subsequently, the use of statistical methods in other studies involving child utterances and phone observations is discussed (Wong and Irwin 1983, Davis and MacNeilage 1990, and Ratner 1994).

1.4.1 Descriptive and inferential statistics

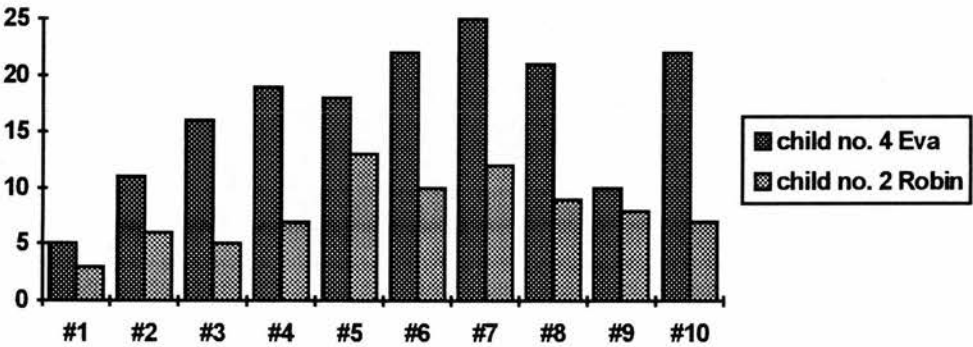
By means of descriptive statistics, data can be visually or numerically presented. The frequency distribution table, for instance, for [t] phones occurring in initial position in each session for each child can be determined. This is illustrated for Eva (4) and Robin (2) for #1-10.

(6)

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
4	5	11	16	19	18	22	25	21	10	22
2	3	6	5	7	13	10	12	9	8	7

(7)

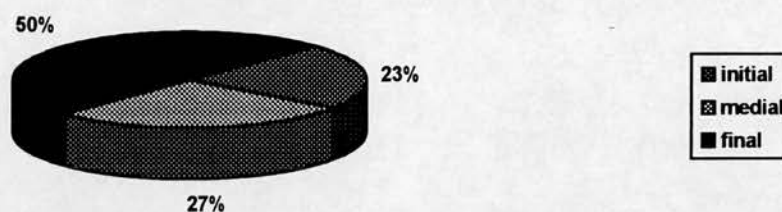
The number of initial [t] phone realisations during #1-10.



Also, the proportion of initial [t] phones in comparison with the medial and final position in the word at #1 for Eva (4) can be presented in a diagram, amongst other things, as shown below.

(8)

**Distribution of [t] phones in initial, medial and final word position (4, #1) in %.**



This information as such, presented visually or not, is not of any help in constructing the phonological system of these children during #1-10 (nor would the number of [t]'s in all three word position be helpful). In this (isolated) form, the data does not provide information about the function of [t] in relation to the other sounds in the child's utterances, which is essential when reconstructing the phonological system that underlies these utterances.

The other function of statistics is inferential (Butler 1985:10). On basis of the distribution range of a set of data, a hypothesis can be formulated, and expectations can be inferred about a more general group. The starting point for inferential statistics is the formulation of a main question on which the hypothesis is based. Within the context of the ChildPhon and Cruttenden data, such a question/hypothesis could relate to the data that forms the starting point for the construction of the underlying phonological system.

A possible question is, for instance, whether the phones observed in a child's output are rare and/or accidental occurrences or whether they are systematic realisations of underlyingly existing phonemes (cf. Greene and D'Oliveira 1982:33-34). Starting from the assumption that if a contrast is present in the child's system, this is expected to be expressed in the form of a reasonable number of times (so as to form a pattern), the hypothesis could take the form of "instances of phonemes occur more times" or "an n-number of occurrences is significant, i.e. a phoneme is present underlyingly". Such statements, however, bring up various problematic aspects, relating to both the data as such and to the background assumptions concerning the acquisition of phonology. Firstly, the number of occurrences of a particular phone in a recording session is closely related, amongst other things, to the number of times the child realises a particular word. In the case of a

child that is actively practising a word by attempting many realisations or a child whose attention is drawn to a particular object during a recording session, the number of occurrences is a reflection of his focus of attention rather than of his acquired phonological system. On the assumption that “instances of phonemes occur more times”, this would distort the data. As the occurrences in the data are dictated by the target words, absolute numerical counts do not appear to be meaningful when establishing the child’s underlying system.<sup>14</sup>

Furthermore, taking into account non-contrastive variability, the identity of a phone as such does not provide conclusive evidence with regard to the underlying phonemes. The child’s phonological system is characterised by the limited number of contrastive units during the early states of acquisition, and consequently his output is characterised by the wide phonetic range that represent the realisations of a particular contrastive unit. The occurrence in the data of a “significant” number of [χ] phones does not necessarily point to an underlying /χ/ phoneme. For instance, the underlying system might at that point have the form stop *v.* nasal, and [χ] could be a realisation of the contrast unit stop. In the case when there is an underlying contrast labial fricative *v.* fricative, this phone could represent the latter category and the non-contrastive variability implied by the contrast: the target segment could be /s/ or /χ/, for instance. The referential statistical method would, in first instance, be helpful in determining which data is “phoneme material”, as opposed to exceptional occurrences. When constructing the phonological system, however, information on the underlying contrasts is not available at that point in the process, and data concerning isolated phone distribution can thus be concluded to be not helpful.

It seems that any basic question for inferential statistics that refers both to the phonetic level (observations and counts of phones), as well as to the phonological level (underlying contrastive units) has to take into account the identity of the child’s phonological system at a given time. As the question itself was intended to decide which data was appropriate to use in order to construct the child’s system, inferential statistics appears not to be of help. It is therefore concluded that a direct analysis, as discussed in 1.3.4 above, of the child’s realisations during an observation session, taking into account the target word and the history of individual words, is a more constructive way to determine the underlying phonological system of a child.

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<sup>14</sup> The direct effect of this could be avoided by taking into consideration only non-repeated realisations of target words, and thus by selecting the child’s data.

#### 1.4.2 *Statistics in child language literature*

The application of statistics employed in other studies into the acquisition of phonology is discussed here. The research considered is based on phone observations as well.

Wong and Irwin (1983) present a study based on 100 children at five age levels, namely 18 months, 2, 3, 4, and 6 years old. The twenty subjects for each level were recorded once (twice for the 18 months group) (1983:9), and the collected data was categorised in '22 vowel-like phonemes and 25 consonants' (1983:11). Inferential statistics are employed for the interpretation of the possible effects of age, sex, phoneme, etc. Analyses, for instance, entailed the comparison between 'the relative frequency of vowels and consonants and an examination of the relative percentage of correct production by female and male speakers [i.e. children]' (1983:24).

This investigation does not take into account the longitudinal development of the child's output (nor of his phonological system). Also, the use of "phoneme" seems odd, for example, in sentences like 'for the 6-year-old sample, /ð/ was entered 196 times and made up 4 percent of the 5,187 phonemes summarised' (1983:21). The inferences attained thus appear to refer to the phonetic output at different age levels, and not to the phonological development.

Davis and MacNeilage (1990) investigate aspects of correct vowel production in acquisition (the relation between speech and babbling, the correct production of consonants, and the particular problems of producing multi-syllabic words) (1990:16). Their material is based on 39 recording sessions of one subject (14 months at onset recording) over a period of six months. The consonants in the data were analysed for place of articulation only. The vowels were categorised for 13 vowel categories (1990:18). These categories are consistently presented as phones (between square brackets), and no claim is made regarding the underlying vowel phonemes. The data is presented in terms of percentages, frequencies and relative frequencies. No method of inferential statistics is applied.

Ratner's (1994) discussion is based on the data from three groups of three girls. Each subject was recorded three times at 6-week intervals when playing with their mothers. The first group was preverbal (between 13-18 months old at the onset of the study), the second group used single-word utterances (between 13 and 20 months old) and the third group primarily used 2 and 3 word

utterances (between 17 and 21 months old). The recorded data is transcribed and presented between square brackets. These segments are referred to as “sounds”. In the discussion, reference is made to frequency of vowel use, tendency to use a particular sound (in percentage of occurrence), pattern of sound usage, etc. (1994:344-45). It appears that Ratner (1994) looks at the distribution of phones only. The statement that ‘samples of young children’s ... speech [are used] to suggest ways in which the child’s phonological system matures’ (1994:325) thus seems to be only indirectly correct. The phonological system can be established on basis of the child’s output, i.e. phone observations. An analysis of these observations, however, does not directly provide information about the evolution of the phonological system.<sup>15</sup> Moreover, the methods used in Ratner’s (1994) discussion concern descriptive statistics.

#### 1.4.3 *Conclusion*

The visual presentation of the information regarding the sounds in the realisations of the children studied does not provide an insight into the way their phonological system develops, and is thus rejected for the aim of the study here. In order to determine whether the phones observed are systematic realisations on basis of the underlying contrasts or whether they are random and rare occurrences, inferential statistics were considered. In this context, the basic question underlying the hypothesis for inferential statistics proves a complex issue, the main reason being that reference is made both to the phonetic and the phonological level. The information of absolute numbers of phone occurrences does not appear to be meaningful in determining the underlying phonological system. It is therefore concluded that application of statistics is not helpful for the study proposed here. The absence of applied (inferential) statistical methods appears to be in accordance with other studies based on phone observations during acquisition as discussed here, though it should be noted that these studies do not make reference to the phonological development proper.

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<sup>15</sup> This is reminiscent of the references employed in the discussion on place of articulation in the literature (see II4.2.3). There too, phonological development is discussed with reference to the phonetic level only. This lack of phonological outlook does not seem to warrant the use of “phonological analysis” in Ratner’s (1994) title.



## 2. Levelt (1994)

Levelt (1994), *On the acquisition of place*, deals 'with aspects of the acquisition of place feature representations in speech production' (1994:4), and is based on the ChildPhon database (see 1.2.1). Significant claims are made regarding early phonological acquisition, in particular underspecification in early segment representation and choice of feature framework, and therefore an extensive discussion of this research is appropriate here.

One of the aspects discussed in Levelt (1994) is the interaction of vowels and consonants with respect to their place of articulation features. This relates to the reanalysis of Consonant Harmony that is presented, and leads to a proposal for 'a model of the acquisition of a place feature representation' (1994:4), as well as a discussion on the acquisition of vowel height. Levelt (1994) is not concerned with the acquisition of the segment inventory of a language (1994:4-5).

Below, the feature framework and reanalysis of consonant harmony as proposed in Levelt (1994) are presented (2.1). The acquisition model and its development are given in 2.2. Subsequently, a critical discussion of various aspects in Levelt (1994) is conducted, addressing the model of acquisition as such (2.3.3-4), as well as the account of harmony forms, and the representation of low and round vowels (2.3.1-2).

### 2.1 **Representation and harmony**

#### 2.1.1 *Choice of feature framework*

Levelt (1994) presents an overview of the history of place feature representations. Several notations for place of articulation are discussed, such as the Jakobsonian feature system, SPE features, dependency phonology, radical CV phonology and feature geometrical representations.<sup>1</sup> For the aim of evaluating Levelt (1994), the discussion of the feature models presented and, subsequently, the aspects that are considered here in more detail are only those relevant with respect to the outcome, that is, with respect to the model ultimately adopted as working model for the acquisition process.

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<sup>1</sup> For references, see Levelt (1994: chapter 3).



The capacity of a place feature model to express natural classes is given importance (1994:13). It is concluded that as a consequence of the introduction of Dorsal as a main articulator in segment specification, ‘labials, coronals and velars stopped having natural class relationships among each other’ (1994:43).<sup>2</sup> That is, the notation including Dorsal was not able to express these alleged “natural class” relations. Despite this drawback, the final choice is for a ‘current feature geometrical representation of Place’ (1994:44, as such a model would be able to express the interactions between vowels and consonants that are claimed to be recurrent in the early stages of phonological acquisition (1994:43). Namely, such a model would include a Labial node in the representation of labial consonants and round vowels, a Coronal node for both coronal consonants and front vowels, and a Dorsal node for both velar consonants and back vowels. The choice of feature geometry is narrowed down on the basis of a reanalysis of consonant harmony.

As will become clear below (2.3.2.2), the position and, possibly, the existence of the feature [round] under the Labial articulator is a point of relevance. This feature is discussed in relation to the place node as proposed in Lahiri and Evers (1991) (Levelt 1994:40-41). The representation of several segments is discussed, e.g. labialized consonants and round vowels, that would be problematic for the feature [round] as it is proposed. Several alternatives are suggested and subsequently rejected. No concluding or decisive statement is given following this discussion; the Labial/[round] construction is not rejected. Later in the discussion regarding [round], it is mentioned that ‘[i]mplementation of dependency into Lahiri and Evers’ [*sic*] model would probably be the thing to do’ (1994:42). This suggestion to introduce some sort of dependency relation under the Labial node, as proposed in Selkirk (1991) (Levelt 1994:41), does not appear to be followed up, nor is it referred to again.

To sum up, on basis of the interaction between vowels and consonants as a characteristic of early phonological acquisition, the model favoured in Levelt (1994) is a feature geometry model. This enables a representational grouping of labial consonants and round vowels, of coronal consonants and front vowels, and of velar consonants and back vowels.

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<sup>2</sup> Previous to Sagey (1986), Jakobson’s [+grave] and SPE’s [–coronal] grouped labial and velar, [+anterior] in SPE grouped labial and dental, and dependency phonology [l] grouped velar and dental [*sic*; Anderson and Ewen (1987:241) refer to this group as alveolar and denti-alveolar] (Levelt 1994:33-34).

### 2.1.2 *Consonant harmony: a reanalysis*

Consonant harmony is traditionally viewed as the assimilation of a consonant to another non-adjacent consonant. According to Levelt (1994), the discussion of modern accounts of consonant harmony points to two relevant aspects: planar segregation and underspecification. (For a full discussion, see Levelt 1994:47-59) The “Line Crossing Prohibition” makes planar segregation of vowels and consonants necessary if a CC assimilation in a CVC structure is assumed. The root structure constraint, which relates to the predictability of the linear order of consonants and vowels, is concluded to be not sufficiently strong (1994:53-55); ‘an absolutely predictable consonant-vowel sequencing in syllables [is] lacking’ (1994:70). Planar segregation is not a feasible idea, because:

Planar segregation is present in a language when the linear order of vowels and consonants in the surface structure of morphemes is predictable. One circumstance that renders linear order predictable is when a language has a sufficiently restricted root structure constraint (1994:53 after McCarthy 1989).

An ‘exhaust[ive]’ discussion of the possibilities for regarding the consonant harmony phenomenon as CC harmony remains futile (Levelt 1994:59). According to Levelt (1994), different aspects make it clear that the CC scenario is not feasible, such as spreading one feature instead of the Place node, the difficulty of bi-directional spreading, the scenario of underspecified consonant and specified consonant that gives the wrong predictions, etc. (for details, see 1994:51-59). The concern here is with the proposed reanalysis.

The next step in Levelt (1994) is to look at the ‘circumstances’ under which the consonant harmony phenomenon occurs, where ‘circumstance’ is defined as ‘the Place of Articulation feature of the vowel intervening between the two consonants’ (where Place refers to articulator node and not to vowel height)<sup>3</sup> (1994:60). This leads to the discovery of relations between certain classes of segments, namely, between [+round] vowels and labial consonants, front vowels and coronal consonants, and back vowels and dorsal consonants. These relations are ‘clearly not specific to child language, but are a universal characteristic of language’ (1994:61). The idea that the vowel could act as the trigger of the harmony process is strengthened by the observation that a

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<sup>3</sup> The assumption here, I think, is a Place Node that branches into an Articulator Node (Labial, Coronal and Dorsal; the first two of which have dependent binary features: [round] for Labial, and [anterior], [strident] and [distributed] for Coronal), and a Tongue Position Node that has [high] and [low] (Lahiri and Evers 1991) (Levelt 1994:39).

consonant can assimilate to, for instance, labial while no labial consonant is present, but merely a round vowel (1994:62-63). Consonant harmony is thus concluded to be VC harmony (see also I6.2.2 for a discussion of Levelt (1993) concerning the VC harmony proposal).

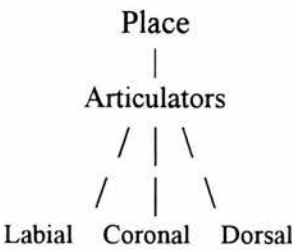
Different proposals that have presented a similar idea are mentioned (Jakobson 1968, Ingram 1976, Stoel-Gammon 1983, Davis and MacNeilage 1990) (Levelt 1994:70-71). The chapter is concluded with the question why VC harmony occurs (1994:1971):

... the phonological system of the child is, in the course of development, organized in such a way that words can only be produced in one way and not in another. Forms that, compared to the adult models, appear to be cases of Vowel-Consonant Harmony are, in this account, adapted to the child's system. ... a proposal along these lines will be worked out in more detail and it will turn out that part of the data presented ... is indeed a product of the developmental state of the child's phonological organization. However, the Vowel-Consonant Harmony data of the majority of the children are not very systematic and often exist next to non-harmonized versions of the adult model. In these cases, the assimilations [*sic*] probably reflect planning problems: as long as the child is not able to fully control the production of combinations of segments with different articulator features, assimilations can occur.

So, planning problems and the child's system are regarded as the motivation behind VC harmony (for the latter, see 2.3.1).

The representation of such harmony processes is in terms of a simplified version of a feature geometry proposal, namely Lahiri and Evers (1991). Two other feature geometries are discussed as well. However, the data 'provide no decisive arguments for either of the [models] discussed' (Levelt 1994:69). The Lahiri and Evers geometry is considered adequate for the purposes pursued here (see also 2.3.2.2). The place of articulation model assumed in Levelt (1994) for the description of the acquisition process is as follows (1994:70):

(1)



## 2.2 Acquisition model for place of articulation

A model for the acquisition of place of articulation during the early stages of phonological development is discussed in Levelt (1994: chapter 5). A outline of this proposal is given in this section. A discussion of (aspects of) this model and its merits in reflecting the acquisition process are to be found in section 2.3.

### 2.2.1 Output system

The 'gradual developments in the phonological output system of the language learner' (1994:82) are claimed to account for the output during the acquisition process. This phonological output system has three components (based on Levelt, W.J.M. 1974):

(2)	F	Phonological <u>features</u> that need to become associated to some higher organising unit in the output representation.	Labial and Dorsal.  'Coronal is presumably not specified in the output representations' (1994:82).
	U	The phonological <u>units</u> that carry a feature specification, i.e. higher organising units.	WORD, [WORD, WORD], WORD-P (see below).
	C	<u>Constraints</u> on the output representations.	

The output system consists of (U, F, C). 'In the model proposed here developments only take place in the components U and C' (1994:82). Moreover, the discussion in Levelt (1994) concerns the place of articulation (POA) features only. The development in the U and C components is as follows (1994:83-84):

#### U

(3)	I	The only unit available for feature specification is WORD, which indicates the segment is not an actively manipulatable unit yet.	e.g. {WORD, Labial}: all segments of the word have a Labial specification. {WORD}: all coronal segments.
	II	The left edge <sup>4</sup> becomes available, referring to either consonant or vowel.	{[WORD, POA feature]}
	III	The vowel can be referred to by means of WORD-Peak, i.e. the sonority peak of WORD, 'in order to indicate that consonants and vowels are still dependent on their encapsulation in the WORD with respect to POA feature specification' (1994:83).	{WORD-P, POA feature}
	IV	The right edge becomes available as a unit.	{WORD}, POA feature}

<sup>4</sup> Edge in Levelt (1994) refers to the segment adjacent to a word boundary, for instance, in #C<sub>1</sub>V<sub>1</sub>C<sub>2</sub>V<sub>2</sub>#, C<sub>1</sub> and V<sub>2</sub> are regarded as being left and right edge, respectively.

(4) C

I	Preference for Labial specifications over Dorsal.	Constraint on Dorsal specifications, *Dorsal.
II	Labial is specifically assigned to the left edge, Dorsal can only be assigned to right edge or word peak. (Note that the left edge has become available in U.)	Edge-constraints: Labial directed to left edge, Dorsal excluded from left edge (replacing former Dorsal constraint). Labial → [WORD] *Dorsal → [WORD]
WORD is abandoned as unit, edge constraints no longer dominantly present. Segment specified for any POA feature can occur anywhere in the produced word.		

The development in U and C as outlined above is formulated on basis of four observations made concerning the data in the ChildPhon database. These observations are (1994:81, 181):

- i) At first no combination of different POA features are found in words produced by the children.
- ii) No combinations of either a coronal consonant and a labial vowel in CV sequences, or a coronal and a labial consonant in VC sequences are found in the data for some time.
- iii) C<sub>1</sub>VC<sub>2</sub> sequences where C<sub>2</sub> is a labial consonant while C<sub>1</sub> is a non-labial consonant do not occur in the data for a long time.
- iv) C<sub>1</sub>V(C<sub>2</sub>) sequences where C<sub>1</sub> is a dorsal consonant, do not occur in the data for a long time.

The notational framework that supplies the features in F is the simplified feature geometry model of Lahiri and Evers (1991) (see 2.1.2). With regard to the segments of Dutch, the language the children of the ChildPhon database were acquiring, the following place features refer to them (Levelt 1994:80):

(5)	Labial	round vowels	/ y ø u u o ɔ œy /
		labial consonants	/ p b f v m v /
	Coronal	front vowels	/ i e ε ɪ y ø u ei œy /
		coronal consonants	/ t d s z n j l /
	Dorsal	back vowels	/ u o ɔ a ɑ au /
		dorsal consonants	/ k χ x ŋ R /

Until the occurrence of Dorsal consonants in the child's output, there are either coronal or non-coronal sounds in his output, the latter characterised as Labial. Furthermore, the specification of the vowels is considered to be represented as non-complex segments (1994:80-81):

- 'As long as there are no dorsal consonants in the data of a child, then, the back round vowels will be referred to as Labial' (1994:80).
- As children do not consistently distinguish between front round and plain front vowels, it is not considered necessary to make this distinction yet. Both round and non-round front vowels are referred to as Coronal.

2.2.2 *Model and data*

With this model of development in mind (2.2.1), the output data of one child, Robin, are initially looked at (ChildPhon, child no. 2; see 1.2.1). The development of his phonological output system over time is concluded to be in agreement with the model outlined above (see Figure 2) (1994:93, 104). The occurrence and disappearance of elements in U and constraints in C are indicated in relation to the age of the child at the time of the observation. For the development following the C.II stage (see 2.2.1 above), the following is noted (1994:106-7):

As a final step in the development, it will be assumed that the sonority peak becomes equated with the concept "vowel", and the edges of the WORD that are not sonority peaks with the concept "consonant". The WORD is from then on phonemicized. The edge constraints lose their grip on the output representations - probably because the "edge" has been replaced by "consonant" as a unit for specification in the representations - and we will find any combination of consonants and vowels in the child's productions.

Part of the discussion of the development of Robin's output is the comparison between certain adult CVC sequences and the child's realisation thereof. These adult sequences are predicted not to occur in the output of the child on basis of the constraints in C valid at that point in development. An example will be discussed below to illustrate how the model actually works. The sequence C<sub>dor</sub>VC<sub>cor</sub> in the adult output is not expected to be found in the child's output at the time when the constraint on initial dorsal consonants is still valid. The realisations of this sequence by the child were as follows (1994:97-98):

(6)

<u>realisation</u>	<u>proposed representation</u>	<u>example</u>			
C <sub>cor</sub> V <sub>cor</sub> C <sub>cor</sub>	{WORD}	<i>clown</i>	'clown'	/klaun/	['dan]
		<i>kaas</i>	'cheese'	/kas/	['tas]
		<i>kan niet</i>	'not possible'	/kanit/	['tanit]
		<i>koud</i>	'cold'	/kaut/	['taut]



$C_{cor} V_{cor} C_{dor}$	{WORD}, Dorsal} metathesis dorsal at right edge CV unspecified	<i>katten</i>	'cats'	/katə/	[taka]
$C_{lab} V_{lab} C_{cor}$	{[WORD-P, Labial]} dorsal is ignored based on labial <sub>vowel</sub> Labial → [WORD, Labial VC harmony	<i>schoen</i> <i>gooien</i> <i>goed</i>	'shoe' 'throw' 'good'	/sxun/ /χojə/ /χut/	[pun] [vojə] [fut]
$C_{cor} V_{dor} C_{cor}$	{WORD-P, Dorsal} based on dorsal <sub>vowel</sub> , i.e. back and round vowel	<i>groot</i>	'big'	/χrot/	[zot]

The phonological development of place of articulation of five other children is also analysed and presented, with reference to the development of Robin. The different aspects relevant to the gradual segmentalization of the WORD unit and discussed in the context of child utterances are WORD specification, emerging of "edge" as unit in U, edge constraints, comparison of adult sequence and child realisation, etc. They are considered in relation to the data of Jarmo, Tom, Noortje, Eva and Elke.<sup>5</sup> Their data are analysed and are presented with reference to their development in U and C. The same units and constraints are discerned as in the case of Robin (1994:119-20). The timing and/or order of occurrence differs, though (see 1994:107-20). As conclusion to this discussion, the model is claimed to be able to generate every form encountered in the output data, 'while it did not generate forms the child did not produce' (1994:121). Regarding the development in U (see 2.2.1), it was already stated that (1994:84):

The order of the developments in III and IV will ... turn out to be variable: for some children state IV precedes stage III. Furthermore, although a preference for Labial specifications over Dorsal specifications in output representation is found for all the children in this study, the extent to which Dorsal specifications are banned in the output representations of the different children varies.

The above overview constitutes the core of the proposal concerning the output system. The next section discusses several aspects relevant to the model proposed.

<sup>5</sup> See III.2.1 for more information on (the data of) these subjects. Noortje was between 1;7.14 and 2;11.0 during the period of observation.



## 2.3 Aspects of the acquisition model

### 2.3.1 *VC harmony*

In relation to the underspecification of coronal, which amounts to the interpretation of segments that are not specified for labial nor for dorsal as coronal, the scenario of VC coronal harmony proposed in Levelt (1994) gives rise to a few queries. The observed recurrent interaction between vowels and consonants forms the basis for the VC harmony scenario proposed, namely, labial consonants and round vowels, coronal consonants and front vowels, and dorsal consonants and back vowels, which are assumed to be represented by Labial, Coronal and Dorsal, respectively, (1994:43-45, 62-63) (see 2.1.2 on the reanalysis of consonant harmony).

From the discussion of VC harmony, it does not become clear how a coronal segment, by definition not specified, can be a trigger for coronal harmony as it is not specified and thus there is nothing in the representation to constitute that trigger. Nor is it clear what would be spread in the case of coronal harmony.<sup>6</sup> On basis of the underspecification of coronal, the prediction would be that labial and dorsal harmony would apply more often, especially in those slots where there is no specification, i.e. an easy landing site, namely coronal segments. The VC harmony proposed might take place at a later stage when feature specification of coronals has been completed. However, this aspect is not clarified.

VC harmony becomes possible only if WORD-P is available as a unit in U. Given the acquisition scenario in Levelt (1994), this pre-requires the differentiation of the left word edge, [WORD. The account presented also raises the question how a coronal that is not specified can be the trigger for VC harmony and spread towards a specified consonant. This would entail not only spreading of a (non-represented) place feature, it would entail the deletion of the feature that is associated with the [WORD unit. Indeed, it is assumed 'that the process involves spreading of the vowel place feature, with simultaneous delinking of the original place features of the targeted consonant'

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<sup>6</sup> The following statement in Levelt (1994:55) appears plainly unreconcilable with what follows, i.e. the VC proposal, and will be ignored so as to be able to continue the discussion of this proposal: 'The assumption that an underspecified consonant in the underlying representation of a word triggers Consonant Harmony - in order to regard the process as automatic and unmarked - makes sense only if the consonant forming the target of assimilation, being unspecified for place, will not be able to act as a trigger for Consonant Harmony at the same time. The underspecified consonant has no place features underlyingly, and is thus not able to spread a place feature' (1994:55). No further mentioning is made of this aspect - underspecified segment can not spread - (in chapter 4 and 5), nor is it made clear whether/how this is different for vowels in VC harmony.

(1994:67). If the delinking were not assumed, the alternative scenario would only allow coronal harmony to a non-specified consonant slot, which by definition is coronal already. Apart from the redundant consequences of such a harmony process, this alternative scenario would, intuitively, be part of an acquisitional account as such, as it assumes that the specification of segment slots is not (completely) acquired yet, and thus that the motivation for harmony forms in child language is intrinsic to child language. Although adopting delinking as part of (VC) harmony may make it possible to describe this phenomenon, it does not explain why it is characteristic of acquisition data, as opposed to adult language.

On a more general note, VC harmony is defined to be available when both word peak, WORD-P, and left word edge, [WORD, are available (see 2.2.1). WORD-P is a prerequisite for VC harmony and [WORD, left word edge, is claimed to become differentiated from the {WORD} unit before other units. This means that VC harmony is predicted to occur only at later stages when these two units have become part of the phonological system and are specified in U. This model excludes VC harmony from the earlier stages as the description and notation proposed make it impossible to assume VC harmony before the differentiation of word edge and word peak. It appears that the claim expressed by the model proposed is too strong as the notation does not allow the description of a particular phenomenon in the data. The statement that 'many CV harmony cases are due to the developmental stage of the child's phonological output system' might be intended to refer to the placement of VC harmony cases in later stages, and consequently, exclusion in earlier stages. The latter is theoretically unsound, the former is different from what is generally assumed (see 16.). If VC cases prior to the differentiation of WORD-P and [WORD are analysed in a different way, then this is not discussed clearly.

The picture of what is what in terms of harmony remains vague. The following fragment is part of the final conclusion on the reanalysis of consonant harmony, i.e. CC harmony (1994:71):

The vowel is probably a good anchor to hold on to for the child, since it is both a perceptually salient segment, and an important phonological unit as head of the syllable.<sup>7</sup> This brings us to the other question, namely whether it is indeed always the vowel that acts as the 'trigger' for assimilation. This is not the case. ... it will become clear that, like some of the Vowel-Consonant Harmony cases and the cases that appeared to be real

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<sup>7</sup> Neither aspect becomes clear in the articulatory based description of a linearly regarded CVC string, on which the model in Levelt (1994) is based.

instances of Consonant Harmony, many Consonant-Vowel Harmony cases are due to the developmental state of the child's phonological output system.

The CC and CV harmony cases mentioned here are not discussed in Levelt (1994), nor are examples provided.<sup>8</sup>

There is drawback of a different nature regarding the word peak and word edge. During the second developmental phase in U, the left edge of WORD becomes available as a unit; 'The "edge" refers to either a consonant or a vowel in the production of the child' (1994:83). Indeed, the labial vowel in an utterance like [otə] for target /oto/ *auto* 'car' is regarded as an illustration of the association of labial with the left word edge (1994:89). However, the generalisation of this category to include both consonants and vowels is not consistently used. At a later stage in the development, the exclusion of vowels from the "edge" is required, and WORD-P and [WORD are theoretically not the same segment anymore. This makes it necessary to exclude vowels from a statement like 'it will be assumed that ... the edges of WORD that are not sonority peaks [i.e. WORD-P] [become equated] with the concept "consonant"' (1994:106). (See also 2.4 on edge-peak versus vowel-consonant representation.)

### 2.3.2 *Description of vowels*

#### 2.3.2.1 Low vowels

In relation to forms in the earliest recorded set for Robin like [ta], [an] and [mama] that do not conform to the representation proposed at that stage of development, namely {WORD} and {WORD, Labial}, it is stated that (1994:86):

... the vowels /a/ and /a/ are considered to be neither front nor round. It is assumed that these vowels do not need a POA feature specification for Dorsal,<sup>9</sup> since they can be uniquely referred to by the feature [+low]. The complete representation of the forms [ta], [an], on the one hand, and [mama] on the other] is {WORD, low} and {WORD, Labial, low} [, respectively].

Regarding the segmental representation in the model presented, it is proposed that [+low] will automatically be associated to the sonority peak of the word, i.e. vowel position. What the trigger for this association is, does not become clear (1994:86-87). Prior to this discussion, Levelt (1994)

<sup>8</sup> Cf. Levelt (1994:96) for a counter example of CC harmony, which is claimed to be the result of a constraint in C, namely that Labial should be associated with the left edge of the word, for example, [fep] for /zep/ *zeep* 'soap'.

<sup>9</sup> /a/ is not considered dorsal or back; given the overview of the vowels in the Dutch (acquisition) data, it is a central low vowel (Levelt 1994:172, Figure 43).



Also, to represent low vowels as unspecified (until associated with [+low]) has as a consequence that no distinction can be made between low and coronal vowels.

With regard to the [+low] specification, this is an instance where a more elaborate description than the Labial-Coronal-Dorsal representation proposed is necessary according to Levelt (1994). On the one hand, it is claimed the [+low] will be automatically associated to the sonority peak if this is constituted by a low vowel, i.e. /a/ or /ɑ/, in a word (see above). On the other hand, there appears to be unclarity regarding the units available in the child's system. At the moment that the feature [+low] is 'automatically associated' with the sonority peak of the word (1994:86-87), i.e. the word peak, WORD-P does not yet exist as an element in U. For Robin, the development in U only differentiates between WORD, [WORD and WORD-P at age 1;8.7 (1994:104). For his initial set of words at age 1;5.11 (1994:86), however, the [+low] association is proposed. These seem contradictory claims. Also, it is claimed throughout the proposal in Levelt (1994) that [WORD is the first unit within the word to be differentiated. This claim appears to be unattainable if the word peak is supposed to be available for [+low] association from the initial stages of development on.

Ironically, the early unit of representation in the system proposed, namely {WORD}, is basically not able to represent a very frequent (across children) early word: *mama*. It is clear from the development proposed (1994:121-22) that an early differentiation within CV is rejected. This claim forms the bulk of Jakobson's argument in his discussion of early acquisition. However, the "zipper" model, presented in Levelt (1994) as an illustration of early vowel development in terms of place of articulation, is derived from the differentiation philosophy behind that claim, albeit concerning the vowels only.

The contours of Jakobson's model of the acquisition of vowel height, reconstructed ... as the Zipper model of the acquisition of vowel height, are clearly recognizable in child language data. The model simply entails that high and low vowels are acquired first, while the remaining vowels become available gradually, proceeding from the higher to the lower vowels (1994:173).

... we will call Jakobson's model the "Zipper model" of vowel development. The Zipper model predicts that the opposition /e/ - /o/ cannot arise before the opposition /i/ - /u/ is acquired (1994:126).

So, with regard to the representation of low vowels, the dual representation as labial and coronal, i.e. underspecified, seems inconsistent. Moreover, either specification generates different representation problems. Firstly, underspecification of low vowels prior to the [+low]



specification obscures the distinction between front and low vowels when [+low] is to be associated with the latter class of segments. The association of [+low] to low vowels as such appears to have to be later in the development because the WORD-P that is required only becomes available after [WORD] has been introduced into the child's system. Not specifying low vowels by means of Labial, Coronal or Dorsal provides them with a different status from front, round and back vowels, and excludes them from VC harmony. Secondly, a representation as labial inappropriately attributes rounding to these non-round vowels (see also 2.3.2.2.).

#### 2.3.2.2 Round vowels

The three consonant-vowel relations - labial, coronal and dorsal - are claimed to be universal, and the natural classes of these segments must receive a classification accordingly (1994:61). In terms of the feature geometry preliminarily adopted, the three universal relations are expressed as follows: back vowels and dorsal consonants - Dorsal articulator; front vowels and coronal consonants - Coronal articulator; and round vowels and labial consonants: [+round] (dependent on Labial), and Labial articulator, respectively. The representation of the three relations seems to be of a different order. Coronal and dorsal on the one hand do not have same status as [+round] representationally. And, the natural class of labial/round segments is not expressed uniformly; it requires two different features, implying two natural (sub)classes. (See also discussion on [round] in 2.1.1.)

As discussed in Levelt (1994:67), spreading of the articulator node of a round vowel implies spreading dependent [+round]. Rather than a labial consonant characterised by Labial, this results in a labialized labial consonant characterised by [round] as well. Also, '[i]t is, obviously, not the case that only [+round] spreads from the vowel, since this would result in labialized coronal and dorsal consonants instead of plain labial ones' as the articulators are not delinked when spreading an articulator dependent (1994:67). So, spreading of articulator/dependent does not give the desired result, nor can the dependent be assumed to spread on its own. Levelt (1994) offers the following answer to this dilemma (1994:67):

We could get around this problem by claiming that since [+round] labial consonants are not part of the Dutch segment inventory the [+round] labial consonants that result from spreading have no independent phonetic interpretation and will therefore be phonetically categorized as the more familiar plain labial consonants.

This, then, raises the question how the child knows that the adult inventory does not have round labial consonants as contrastive segments. A scenario like this could only work if one attributes to the child full segmental knowledge of the adult phonological inventory and its representation. The scenario that leaves [round] out of the representation of the consonants because it does not yet function contrastively would also give the desired result. (Labial harmony would then involve the spreading of Labial; see below.) This, however, requires a child point of view, which is not mentioned (see 2.3.3).<sup>10</sup>

Levelt (1994) is trying to get around the problematic representation of round trigger vowels by pointing out the meaninglessness of a [+round] specification for labial consonants in Dutch. It is concluded that 'Labial groups round vowels and labial consonants' (1994:69). This is reconfirmed by the structure for place articulation assumed here that only specifies the articulators Labial, Coronal and Dorsal (1994:70). This solution/conclusion is not convincing because, amongst other things, it is based on the argument that if a harmony process results in a (consonant) specification that is not encountered in the adult phonology, then the feature can be left out. This argument, however, can not be part of the solution to leave the feature out of the specification of the trigger, i.e. before the harmony process, because for it to be established that the consonant specification is not "meaningful" or encountered in the adult phonology, the problematic feature must spread first. To leave [round], that is the trigger's "natural class identification", out of the trigger specification because spreading of the feature results in an "incorrect" consonant representation does not appear to be a straightforward way around the dilemma at all.

Once again, the tension between adult versus child point of view is noticeable here, and a clarification even more necessary. See discussion in 2.3.3.

With regard to the "original" feature geometry, this model predicts that [+round] requires Labial. Labial does not imply [round]. Assuming a specification Labial only for round vowels, as in Levelt (1994), is a significant deviation from the Lahiri and Evers model. Labial is now assumed to signify [+round] when it is linked with a vowel.<sup>11</sup> In this way, Labial can be said to group labial

<sup>10</sup> Note (Levelt 1994:87) where specification for Labial of low vowels might have a rounding effect on the vowel, which is undesirable too. See discussion in II2.3.2.1.

<sup>11</sup> This raises the question how "vowel" is defined or represented in a model that only distinguishes between word peak, i.e. sonority peak/vowel, and word edge that can refer to both consonant and vowel.



consonants and round vowels. Elsewhere, in the discussion about the motivation for the choice of feature model used in the description of the acquisition of place model, this aspect, namely the leaving out of [+round], is also mentioned. A “simplified” version of the Lahiri and Evers model is assumed, ‘since we do not have to deal with secondary articulation of consonants’ (1994:69).<sup>12</sup> [+round], however, is what identifies the round vowels in that model, and is relevant for that reason. Basically, rather than adopting a simplified version of the existing Lahiri and Evers geometry, a three articulator model is assumed. Labial, Coronal and Dorsal represent the three universal VC relations.

The argument concerning the non-contrastiveness of round labial consonants in Dutch is not convincing. Moreover, it leads to an incomplete representation of the round vowels, as Labial, in terms of the geometry that forms the framework for the discussion. The problem, i.e. representational discrepancy of [+round] vowels and labial consonants, despite their membership of the same natural class, has not been solved. Leaving [round] out of the feature geometry assumed does not address the issue. The simplification discussed makes representational matters for acquisitional data easier, and at the same time denies the proposal itself a mature status as its representation is not in agreement with the original, adult-based feature geometry.

### 2.3.3 *Processes, constraints and representation.*

Regarding the “processes” discussed within the context of the development of units and features in a word, their representational status in the model proposed remains unclear. On two separate occasions the issue is referred to as such, not shedding much light on the question into the nature of the phonological representation(s) attributed to the child.

It should be clear that what will be called ‘process’ throughout this chapter [i.e. chapter 4] is actually the pattern that emerges when comparing a surface adult structure with the corresponding surface child structure, and probably not an actual ‘derivation’ from some underlying representation of the child to a surface structure (cf. Menn 1978b, Iverson and Wheeler 1987) (Levelt 1994:47, footnote 1).

It is stressed again [!] that what is described as a process is actually the way we can relate a child surface structure to the attempted adult surface structure (1994:66).

<sup>12</sup> One of the advantages of viewing traditional consonant harmony as CV harmony is the involvement of secondary place features; ‘Contrary to Consonant Harmony [i.e. CC harmony], which would be a phenomenon exclusive to child language, since primary instead of secondary articulators are involved, Vowel-Consonant Harmony finds parallels in the adult languages ...’ (Levelt 1994:70). This consideration is denied by the place of articulation feature system adopted as this involves main articulators (Labial, Coronal and Dorsal) only (see II.2.1.2).

These statements do not address whether/why/how the adult surface structure is relevant to the child, as the one acquiring the language as opposed to someone observing someone else acquiring a language. By putting together different fragments of the proposal, the picture becomes a bit clearer.

A piece of information concerning the status of the processes and the child's representation can be found in the discussion of realisation  $C_{dor}VC_{lab}$  (1994:100):

... the constraint on crossing association lines is more compelling than the ambition ascribed to language acquiring children like Robin to retain all the phonological material from the adult word in their production.

For something to be retained (in production), it must be contained (in underlying representation). Also, the attitude towards language acquisition expressed here seems to point at a model where a discrepancy is assumed between underlying child representation and child output.

Another relevant fragment is (1994:98):

The small number of attempts to produce adult model words that have an initial Dorsal consonant show [*sic*] that Robin's strategy here is mainly one of avoidance.

If  $x$  does not occur in phonological output representation because of avoidance by the child, then  $x$  needs to be recognisable for the child. For the child to recognise  $x$ , he requires a underlying description of  $x$ . In my own interpretation, the absence of dorsal from the child's output would imply an absence of dorsal underlyingly. Here, however, it seems that dorsal is present underlyingly, and it is the output constraint that causes the avoidance as the child can not produce dorsal. On basis of this fragment too, it appears to be being assumed that underlyingly the child has a more elaborately specified phonological system than can be concluded on basis of output.

The first constraint on output representation posited by Levelt (1994:87) is a constraint on dorsal specifications: \*Dorsal. It appears that the reason for positing (constraints like) this constraint is the need of a filter system that does not allow adult representations that are not found in the child's output to come out, that is to exist as a theoretical possibility to come out (as data overrides theory). However, regarding the nature or effect of the constraints specified in C, Levelt (1994) offers a less straightforward picture. When discussing the child's realisation of an adult CVC sequence (1994:98), it is stated that 'Dorsal cannot appear as the initial consonant in Robin's productions, since there is a *strong constraint* on the representation  $\{[WORD, Dorsal]\}$ '

(emphasis mine). The notion of constraint is generally assumed to reflect something that is “absolute”, concerning something that is not encountered or not predicted to occur. The constraints in Levelt (1994) appear to be flexible in that respect. This is further illustrated by ‘[t]his probably indicates that the constraint on Dorsal specifications does have *some effect* in the child’s output system’ (emphasis mine) (1994:108).

The constraints in Levelt (1994) are thus not statements predicting that some specification will not occur, they do not have “absolute” value. Constraints in this way do not mean something is not expected to occur. It merely is an indication of something being more or less likely to occur (which is concluded on basis of the data once it is part of the child’s output). It does not make any claim about what is possible to occur in a child’s output. It can therefore be concluded that the constraints are descriptive in nature. However, in the conclusion to chapter 5, constraints are repeatedly said to ‘ban’ a particular specification (1994:121) (side-by-side to the statement that a ‘constraint *specifically directs* Labial specifications to the left edge’ (emphasis mine)). Statements like this are not illustrated by the general picture emerging, nor by the application of “constraints”.

Having said this, in an attempt to clarify the assumptions underlying the acquisition model in Levelt (1994) as far as “processes”, “constraints” and representation is concerned, note the following. Concerning the first set of word productions of Jarmo, it is stated that dorsal specifications ‘are not completely banned from output representations’ (1994:108). Dorsal realisations are only found for *kijken* ‘to watch’ and *klaar* ‘ready’. However (1994:108),

... the form [ka] or [ka], for *klaar* ‘ready’ occurs in the data. The target word *klaar* is also produced [ʋa], resulting from a {WORD, Labial} representation rather than from a {WORD, Dorsal} representation. This probably indicates that the constraint on Dorsal specifications does have some effect in the child’s output system;

which leaves this reader clueless about the nature, formal status, and/or theoretical location of this representation.

#### 2.3.4 *Development and representation within the model*

The discussion of the development of place of articulation is conducted within the domain of the syllable. The WORD is the maximal unit in U that is discussed. ‘The part of the word produced by the child that is taken into account is the stressed syllable plus, in case of a bisyllabic word, the consonant of the following unstressed syllable’ (1994:84). No internal structure is assigned to this

unit. The sequencing of segments in WORD, an abstract category, is assumed to be regulated through universal sonority templates (with reference to Fikkert 1994).

The syllable structure of the output words discussed is thus CV, CVC or VC (and C and V); the maximal structure discussed is monosyllabic. However, the output forms presented in relation to the discussion on harmony are disyllabic as well, and even trisyllabic (Levelt 1994:57-58). Also, the occurrence of syllable clusters does not seem to be covered by the account presented. A form like [plɔm] for *balloon* 'balloon' /bɑ'lɔn/ is explained by regarding the vowel as trigger for labial VC harmony. This explanation does not mention the coronal consonant in the initial cluster. [plɔm] is part of Tom's output at 1;7.9 (1994:47). His development in U and C has progressed through all the "standard" phases (1994:120). Assuming that word edge and peak are still current units in U at the time, it is not clear how this form should be represented.

Another representational aspect that relates to development is the realisation of a segment as labial versus coronal. The realisation of the adult sequence  $C_{cor}VC_{lab}$  is discussed in relation to edge constraints. The output forms are 'in accordance with one of the approved representations' (1994:114), namely {WORD}, {WORD, Labial} or {[WORD, Labial]}. No explanation is given for this phenomenon that children realise a coronal segment as labial, i.e. a non-specified segments as specified, before it is realised like the adult segment, i.e. non-specified.

#### 2.4 Conclusion

There is a general lack of acquisitional context in Levelt (1994), within which the study into the development of place of articulation is conducted. This makes it difficult, if not impossible, to gain an understanding of the assumptions underlying the model of place acquisition assumed, for instance, regarding the existence or status of the phonological representation of the child, as well as regarding the notation used. Both the choice of feature geometry and the subsequent decisions about representation appear to be based on a non-child point of view (2.3.3). Because the "processes" discussed do not apply to underlying child representation, and because the constraints refer to the output, nothing is being said about the phonological system of the child, or about how the child's *acquisition* process proceeds.

Furthermore, the interchild differences reported do not agree on the development that is initially proposed on basis of Robin's data (summarised in Figure 36, 1994:104) (2.2.2). This variability is not given any theoretical status (for example, reference to the cognitive nature of acquisition).

This raises the question to what extent the order proposed is fixed or “universal” anyway. The constraints proposed initially prove to be tenable only very “locally”, that is, for that child only. The model proposed appears to be descriptive rather than insightful. This can be explained partly by the *adult* perspective to the child process, partly because of the general lack of acquisitional background.

Once the three articulator model has been adopted, the subsequent description of round and low vowels proves problematic. Subsequently, the representation is adapted to the requirements of the child language studied (round vowels are labial, not [round]) and/or interpreted whilst taking into account the segments in the child’s (target) system ([+low], labial vowels are not meaningfully specified for labial because there is no contrast between round and plain low vowels). As a consequence there is no uniformity, nor continuity between the notational models used for adult and child language.

With regard to the coronal underspecification claim that is accepted for the child’s system, the discrepancy between its effects in child and adult language is not discussed (major place of articulation assimilation and fringe phenomena such as the phonetic nature of secondary articulation processes, respectively). Also, the underspecification of coronal would predict coronal sound to be acquired first, whilst the acquisition data have both coronal and labial segments from the earliest stages on (cf. 2.3.4). The explanation in Fikkert (1994) for the coronal phenomena as such is that coronal is actually still ‘vulnerable’ when place assimilation takes place (1994:243). How and why this situation changes is not discussed.

It is not clarified either how the construction of word edge and word peak that are specified in the U component are envisaged to develop or transform into a consonant-vowel structure (Levelt 1994:106). Moreover, it does not become clear why it is ‘important’, if not advantageous, to ‘[abstract] away from “consonant” or “vowel”’, by using word edge and word peak (1994:121) (see also 2.3.1). It is not indicated whether, after the representational transformation of peak-edge into CV structure, the child is assumed to have mastered all “adult” units and constraints, and/or features. Both this apparent discontinuity between child language and adult language representations, and the adaptation of the feature geometry adopted make it difficult to view the proposal in Levelt (1994) as all-round and universal.

Throughout Levelt's (1994) proposal there appears to be an inconsistency in the underspecification status of coronal. Coronal VC harmony is adopted whilst it is stated that underspecified segments cannot spread (2.3.1). The presence of coronal thus seems to be required for harmony purposes, whereas the notational aspect of the model proposed is strictly based on underspecification. In this respect, the status of coronal is not enlightened by Levelt's study of child language. Rather, the conclusion in McCarthy and Taub (1992:368), in their review of Paradis and Prunet (1991a), applies:

Sometimes coronal consonants are special by virtue of phonological inactivity or invisibility, and these cases form the core of evidence that [coronal] is underspecified. In another set of cases, the special behaviour of coronals requires actual specification of [coronal] ... to engage in assimilation. These conflicting demands have not yet been successfully reconciled.

The role of coronal underspecification is discussed elaborately in 4.. The vowel-consonant relations on which the harmony account in Levelt (1994) is based are reviewed in III7.. A proposal concerning the development of place of articulation, on basis of the ChildPhon data, is presented in 5.. The staging of the development of place is shown to be able to account for the harmony phenomena in the child utterances analysed.



### 3. System evolution: the development of contrast

The evolution of the child's phonological system is discussed here with reference to the utterances of seven children. At the beginning of the recording period (regular sessions during c. one year), these children were between 1;0.10 and 1;6.4. The development of the phonological system for each of the seven children is reconstructed separately on the basis of naturalistic, longitudinal data (five children were acquiring Dutch, two were acquiring English). This reconstruction of the phonological abilities of each child, or the place and manner contrasts present in the child's system, is based on i) the single consonantal phones uttered in spontaneous speech in each session; ii) the diachronic development of the child's forms; and iii) the relation between the child form or realisation, and the target word. The development of the child's system is analysed following clinical methods. Details regarding the recording methods, the subjects, and the data processing and reconstruction method are presented in 1..

The progression of the overall development of contrast in the child's system emerges from the reconstruction of his phonological system for each of the recording sessions. This development is presented in (1) for Robin (2), Eva (4), Tom (7) and Elke (9). Jarmo's (8) data is characterised by an idiosyncratic use of [t], which merits an investigation at closer range. The phonological development of his system is presented in 8. (Figure 12). These children were acquiring Dutch. The English acquisition data is presented and discussed below.

The phonological development of the four Dutch children (2, 4, 7, and 9) is presented in (1), in chronological order. For each session in which a new contrast is observed, all the established contrasts in that child's system are given. Clear trends can be identified in (1) that characterise the acquisition scenarios of these children. These trends are indicated by means of shaded bands, and will be discussed below. From the discussion regarding Jarmo's (8) output (8.), it becomes clear that the development of contrasts in his system is comparable to the developmental trends in (1).

The labels used in the overview of system evolution in (1) are descriptive (i.e. they are not intended to express a connection with any notational framework, see below). The significance of these labels is basically an indication of a set of segments, or natural class, that are observed to group together in the data of the child. For instance, the label *nasal stop* refers to [m n ŋ] in the child's output. At the same time, however, realisations of phones that have not (yet) stabilised in a

(1) 2 Robin

4 Eva

7 Tom

9 Elke

#1	nasal				#1		#1
	stop				#2	stop	
	cont				#3		
					#4		
#2					#5		(nasal) stop
					#6		

#3  
#4  
#5

#6 nasal  
stop  
fricative  
liquid

#2 nasal  
stop  
fric  
liquid

#10

nasal  
stop  
cont

#7

#8 nasal  
lab stop  
fricative  
liquid

#3  
#4 nasal  
lab stop  
fric  
liquid

#11 lab nasal  
stop  
cont

#7 lab (nasal) stop  
#8  
#9 (nasal) stop

#9  
#10  
#11  
#12  
#13

#14 lab nasal  
lab stop  
fricative  
liquid

#6 lab nasal  
lab stop  
fric  
liquid

#12 lab nasal  
lab stop  
cont

#10 lab nasal  
lab stop  
fric  
liquid

#15	lab nasal lab stop lab fric liquid	nasal stop fric	#7 #8	lab nasal lab stop lab fric liquid	nasal stop fric	#13 #14 #15 #16	lab nasal lab stop lab fric liquid	nasal alv stop alv fric	vel stop vel fric	#11 #12 #13 #14	lab nasal lab stop lab fric liquid	nasal stop alv fric	vel fric
#16			#9										vel fric
#17			#10			#17				#15			vel fric
#18						#18				#16			
#19	lab nasal lab stop lab fric lab liquid	nasal stop fric liquid				#19				#17	lab nasal lab stop lab fric liquid	nasal alv stop alv fric	vel stop vel fric
#20	lab nasal lab stop lab fric lab liquid	nasal alv stop alv fric liquid				#20	lab nasal lab stop lab fric lab liquid	nasal alv stop alv fric liquid	vel stop vel fric	#18	lab nasal lab stop lab fric lab liquid	nasal alv stop alv fric liq w/l/j	vel stop vel fric
#21	lab nasal lab stop lab fric lab liquid	alv nasal alv stop alv fric liquid											
#22						#21	lab nasal lab stop lab fric lab liq v	nasal alv stop alv fric liq w/l	vel stop vel fric liq j	#19	lab nasal lab stop lab fric lab liquid	nasal alv stop alv fric liq w/l	vel stop vel fric liq r/j
#23													
#24						#22							
						#23							
						#24							
						#25							

group of their own are generally regarded as being variable realisations of an established set (non-contrastive variability). The segments that are included in the labels describing the development of contrasts are indicated in (2). Furthermore, the following abbreviations are used; *lab* for labial, *alv* for alveolar, *vel* for velar, *cont* for continuant, *fric* for fricative, and *liq* for liquid.

(2)	(oral) stop	[ p b t d k g ]
	nasal (stop)	[ m n ŋ ]
	fricative	[ f v φ β s z θ ð ʃ ʒ x χ ]
	liquid	[ l r j R ]
	continuant	fricative + liquids

The segments mentioned in (2) are on the output sheet (Appendix B; see 1.3.3), and include the consonants of Dutch (cf. 2., Figure 5). Segments that are not mentioned in (2) and occur in the child output studied are added to the appropriate group (and to the output sheet); for instance, [ɹ ɻ c ɕ]. The occurrence of these segments is (very) limited. Concerning the continuant label, this refers to the group of segments that amalgamates the segments under the fricative and liquid labels. In phonetic terms, continuant thus entails the absence of a complete closure in the oral cavity.

The development of the phonological contrast for the children in (1) varies. More remarkable, however, is the correspondence between these system developments. Namely, besides the variability in the development, an overall pattern can be observed across the four system evolutions, which is captured in the shaded bands in (1). These indicate the sessions, or stages, in the development of the children's systems that seem to be comparable. It becomes clear, that, first, there is a differentiation of manner classes: nasal, stop, continuant; or nasal, stop, fricative, liquid. Subsequently, both the oral and nasal stop entities develop a place contrast, namely, labial v. non-labial. This trend characterises the second shaded band. Later, the liquid and fricative entities also acquire this place contrast, and the place opposition for the stop and fricative group is expanded, resulting in labial v. alveolar v. velar. These three trends are observed in the data of all four children.

The data of the two children acquiring English is processed and analysed in a similar way to the Dutch acquisition data. The reconstruction of the system development of the two children is



presented in (3). From the phonological oppositions in the shaded bands, it becomes clear that the trends observed in (1), regarding the system evolution in early phonological acquisition, also characterise the data of these children. The manner contrast is initially between nasal and stop, and later involves fricative and liquid (through an intermediate continuant stage). The place contrast is between labial and non-labial initially, and later, for the fricative and stop groups: labial *v.* alveolar *v.* velar. Note that this last place opposition is not (yet) developed for Jane in #20 regarding the fricative group: the data does not offer sufficient data to establish the velar contrastive entity. Moreover, for those entities marked by  $\wedge$ , there is no evidence to determine whether to specify the labial entity and leave the alveolar entity unspecified, or *vice versa*.

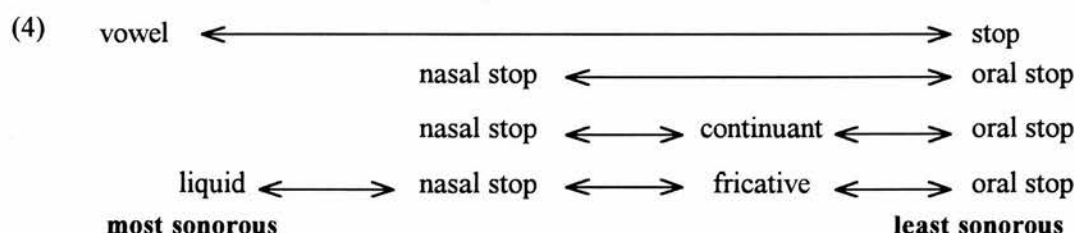
With regard to the voicing contrast observed in the English data in (3) (presented in bold), they appear to occur earlier than voicing in the Dutch data, which is near absent. For Robin (2), voicing seems to have stabilised for labial stops in #19 and for alveolar stops in #20; and for Eva (4), labial stops show a voicing contrast in #8. A general observation was made that voiced segments did not occur in final position. This obviously appears to relate to the final devoicing phenomenon in Dutch. Voicing is stated to be acquired late by children learning Dutch (Beers 1996:37): 'the realisation of voiced stops [is] erratic until the age of 3;0' (1996:40, footnote 2, after Kuijpers 1993). Generally, the voiced-voiceless contrast is regarded here as being one of the later contrasts to be established in phonological acquisition (cf. Shvachkin 1973). Overall the data analysed here does not offer sufficient material for a thorough discussion.

The development of liquid segments in the data of the children analysed is less regular than that of, for instance, stops and fricatives. For most children, however, a labial liquid seems to be stable before other liquids. In the acquisitional data here, however, there is not sufficient information available to fully examine the liquid development, which is assumed to be in full progress beyond the recording period of the data. (It is interesting to note the character of the labial liquid in the data of the Dutch and English children, though. Whereas the data of Dutch children gives evidence of a preference for /ʋ/, the English data shows a clear preference for /w/. This is in agreement with the phoneme inventory assumed for the adult language (for Dutch, cf. Gussenhoven 1992).)

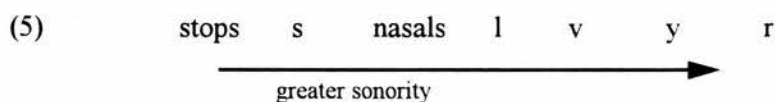


The occurrence of [h] in the Dutch and English acquisition data is investigated and will be discussed in 6. and 9., respectively. The development of [h] and its relation to the realisations of fricatives articulated in the oral cavity has been investigated in a preliminary way. No meaningful correlation has been observed and this aspect will not be further pursued here.

The overall acquisition of place of articulation in the development of the systems reconstructed, across the manner categories, points to labial as the first stable place of articulation. The subsequent development is the contrast between labial *v.* alveolar *v.* velar. Concerning manner of articulation, the development of contrast appears to be directly related to the notion of maximal contrast and sonority. Namely, the new entities that stabilise in the child's system are maximally contrastive in terms of sonority. This is schematically presented in (4). A parallel development can be observed for place of articulation. Namely, the first place contrast divides the articulatory space into labial and non-labial (where the latter is not specified at a that point in the child's development). The subsequent contrast divides the remaining non-labial space, resulting in the opposition alveolar *v.* velar.



The notion of sonority is associated with hierarchical relations among phonological classes (Hankamer and Aissen 1974:131). Hankamer and Aissen (1974) discuss sonority in relation to an assimilation rule in Pali, a classical language of India. They conclude that adequate formulation of this rule requires reference to the sonority hierarchy, which ranks the Pali consonants and expresses their dominance relations in assimilation (1974:135):



The (concept of the) sonority scale is also adopted in Foley (1970) on the basis of evidence from phonological change, and in Hooper (1973) on the basis of syllabification phenomena (Hankamer and Aissen 1974:42-43) (cf. Vennemann 1972:7). The phonetic correlation of the sonority hierarchy, or its characterisation as such, is less straightforward (cf. Ohala and Kawasaki 1984). Hankamer and Aissen (1974:137):

Our position is that the facts force us to recognize the sonority hierarchy as a phonological reality. This being the case, our inability to define a single phonetic parameter which varies along the hierarchy cannot prevent us from according it some status in phonological theory. We do not see why it should be particularly disturbing even if it should turn out that there is no such parameter - this would simply mean that the part of the brain which is responsible for processing speech sounds constructs "psychological" parameters which bear no simple or direct relation to observable phonetic parameters (which is not to say that they bear *no* relation to such observables - only that the relation is complex), which can hardly be surprising in view of what we must assume about the complexity of speech processing anyway.

The outcome of the analysis here presents another argument, based on early acquisitional data, in favour of the phonological reality of sonority. For a discussion of its representation, see III(4.).

The developments for manner and place of articulation, discussed above, reflect the trends observed in the evolution of the phonological system of the children whose data has been reconstructed and analysed here. The following developmental contrasts are thus proposed as representing the acquisition scenario of early phonological development:

- (6)
- |             |   |            |
|-------------|---|------------|
| oral stop   | ↔ | nasal stop |
| stop        | ↔ | continuant |
| labial stop | ↔ | stop       |
| fricative   | ↔ | liquid     |

This scenario will be the basis for the discussion regarding the representation of early phonological development in relation to notational models of phonology in III. First, however, the remaining sections in II will discuss various aspects observed in the acquisition data.

The development of early phonological contrasts proposed by Roman Jakobson (Jakobson 1968) proceeds in terms of maximal contrast along the axes of chromatism, i.e. abundance of sound, and of the quality of lightness v. darkness, or tonality (1968:73-74). The acquisition process is

regarded as being generally motivated by the function that sounds have in the child's phonological system (1968:24). The contrasts that constitute the stratification, according to Jakobson, are (1968:48, 51, 53):

(7)	vowel	↔	consonant
	nasal stop	↔	oral stop
	labial	↔	dental

These are presented in combination with implicational statements or relationships, such as "fricatives presuppose stops" and "back consonants presuppose front consonants". (Jakobson's proposal does not express any (notational) claim regarding the correlation of the laws of solidarity with segmental representation.) These laws of solidarity - 'the acquisition of the secondary value presupposes the primary value' (1968:59)<sup>1</sup> - are claimed to underlie the acquisition of phonology, and also the inventories of languages, in a universal manner (1968:51).

The contrasts in (7) and implicational relationships above, which are the core of Jakobson's (1968) child language proposal, and the acquisition scenario proposed here can be concluded to be in agreement.

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<sup>1</sup> '[A] secondary value cannot exist in a linguistic system without the corresponding primary value' (Jakobson 1968:59).

#### 4. Phonological acquisition and underspecification

##### 4.1 **Underspecification theory**

Phonological representation contains less information than the description of phonetic forms as non-distinctive information is not included underlyingly. In SPE (Chomsky and Halle 1968), for instance, the information that is lacking at the phonological level is derived on the basis of distribution and alternation, so as to attain a complete phonetic representation. Archangeli (1984) introduces underspecification theory that is specifically designed to account for the identity of the information that is and the information that is not contained in underlying representation, and also for the mechanisms that 'are available for providing the missing information' (1984:11). The assumption is that predictable properties in a grammar of a language are not lexically specified; they are derived. The essence of underspecification is thus 'to supply such predictable ... features or feature specifications by rule' (Archangeli 1988:183).

In the underlying representation (and within a binary feature context), only distinctive features, i.e. 'features which actually are necessary to distinguish two sounds' (Archangeli 1984:43), have values specified. Non-distinctive features are redundant features, and their values are supplied by redundancy rules. In the model proposed in Archangeli (1984), all redundancy rules are in the rule component and they apply to the matrix component, i.e. 'an array of the underlying distinctive feature combinations of the sounds of the language' (1984:43). If the entire rule component applies to the matrix component, the result would be fully specified matrices (1984:44). Also, phonological rules proper are assumed to interact with the redundancy rules (1984:12), and can thus apply to a not fully specified matrix.

Three kinds of redundancy rules are proposed that fill in the unspecified values (1984:45):

- (1) a. *default rules* are part of Universal Grammar. They are cost-free and not language dependent.
- b. *complement rules* are created by a process called alphabet formation, which is part of Universal Grammar. The alphabet of a language contains the rule component and the matrix component. It is 'a subset of the sounds possible in natural human language [that] is selected by each language as the building blocks of the words of that language' (1984:43). Alphabet formation requires language particular information to create the complement rules, i.e. to decide which values are selected as matrix value and which are specified by a complement rule (1984:45), cost-free and language dependent.

- c. *learned rules* are language particular rules which must be learned. These are not cost-free.

With regard to the actual principles that determine what the rules look like, and thus which features are specified underlyingly, three different approaches are discussed in Archangeli (1988):<sup>1</sup> i.) *contrastive specification*, ii.) *radical underspecification* and iii.) *inherent underspecification*. Interestingly, Archangeli also comments on the learnability of the first two of these approaches.

(2)

- i. Contrastive Specification assigns specific values to a feature in underlying representation only where that feature is being used to distinguish segments in the respective contexts; non-contrastive values are blank (1988:191).

In order to learn a contrastively specified system, the feature contrasts in that language need to be discovered before the appropriate underlying representations can be determined. In this way, '[t]his model requires knowledge of the full specification of each segment' (1988:192).

- ii. Radical Underspecification includes only unpredictable values for features in the underlying representation ... Values are considered "predictable" if either a context-free or a context-dependent rule can be formulated to insert the absent values: hence predictable values are inserted by rule during the course of the derivation (1988:192).

In Archangeli (1988), the radically underspecified characterisation of an /i e a o u/ vowel system is discussed and three options are presented. It is noted that if there are various options available for the radically underspecified representation of a particular system, then 'the learnability of a system becomes quite a challenge [and] some principle must be included in the theory in order to reduce the burden on simply learning the inventory' (1988:193). According to Archangeli (1984), certain rules are preferred by Universal Grammar, namely default rules (see above). It is thus predicted that the child's first utterances will be in accord with these universal preferences. Later, motivated by language-particular evidence, other specifications and rules will be learned.

<sup>1</sup> See Archangeli and Pulleyblank (1994) for a later view on phonology, rejecting underspecification.

iii. *Inherent (monovalent) underspecification*<sup>2</sup>

Monovalent features are ‘in part inherently underspecified, that is underspecified due to the property of being monovalent’ (Archangeli 1988:190). A segment is either characterised by a monovalent feature, or it is not. In the latter case, the feature is not specified underlyingly.

The following example illustrates the mechanisms of contrastive and radical (under)specification (taken from Archangeli 1988:191, 193), and concerns an inventory containing five vowels of a language such as Japanese or Spanish.

(3)

a. vowel system

	/i/	e	α	o	u/
high	+	-	-	-	+
low	-	-	+	-	-
back	-	-	+	+	+
voice	+	+	+	+	+

b. *contrastively specified*

	/i/	e	α	o	u/	contrasts
high	+	-		-	+	{i, e}; {o, u}
low			+	-		{α, o}
back	-	-		+	+	{i, u}; {e, o}
voice						-

c. *radically underspecified* - some options

	a.	/i/	e	α	o	u/	b.	/i/	e	α	o	u/	c.	/i/	e	α	o	u/
high			-			-				-					+			+
low				+							+					+		
back						+											+	+
voice						+			-	-								
rules		[+low]	→	[-high]				[+low]	→	[-high]				[+low]	→	[+back]		
		[+low]	→	[+back]				[ ]	→	[+high]				[ ]	→	[-high]		
		[ ]	→	[-low]				[ ]	→	[-low]				[ ]	→	[-low]		
		[ ]	→	[+high]				[ ]	→	[+back]				[ ]	→	[-back]		
		[ ]	→	[-back]				[ ]	→	[+voice]				[ ]	→	[+voice]		
		[ ]	→	[+voice]														

<sup>2</sup> Inherent underspecification has two sub-classes: monovalent and node dependent inherent underspecification (Archangeli 1988:190). The latter is a consequence of the introduction of articulator nodes in a feature geometry model of notation, and will not be discussed here.



The identification of the information that is specified and the information that is missing or underspecified is not based on cross-linguistic distributional facts, as is the case in markedness theory. In underspecification theory, the relative specification of any given phoneme 'is language dependent, based primarily on the phonological alternations of that language' (Archangeli 1984:12).

Whether a feature is distinctive or not depends on the language system, not solely on abstract universals. This contrasts with the SPE theory [i.e. markedness theory], in which the markedness of a given segment has a universal value, and the underlying specifications for each feature of a given segment are determined universally, not system-internally (1984:56).

The system-internal character of underspecification is illustrated by the examples from the vowel inventories in Spanish, Japanese and Telugu. The underlying vowel systems of these three language are identical, whereas their underspecified representation is not given Archangeli's analysis, depending on the way the vowels function in the phonological system of which they are part (1984:60).

The formal division between idiosyncratic and derived properties relates to the nature of prosodic structure as this type of structure can be deduced from the information provided by segmental specification in many cases (e.g. syllable structure, stress placement) (Archangeli 1988:183-84). Although it is claimed that 'underspecification theory applies to all phonological information' (Archangeli 1984:12), the focus in the literature has been primarily on the lexical description of (distinctive) segmental features, rather than, for instance, on prosodic structure (Archangeli 1988:184). In the case of the acquisition of underlying phonological representation, the concern appears to have been with radical underspecification (also within the context of an inherently underspecified monovalent notation) rather than with contrastive specification,<sup>3</sup> and even less with the actual identity of the redundancy rules. With regard to the different types of rules, it would seem on basis of Archangeli's proposal that 'certain rules ... preferred by Universal Grammar'

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<sup>3</sup> Note, however, Goad's (1994) argument in favour of contrastive specification. Whereas radical underspecification is process-driven, contrastive specification is based on the assumption that feature selection is based on a language's inventory (which drives its phonological processes). Radical underspecification requires relatively inaccessible data, i.e. phonological processes of a language, as far as language learning is concerned, according to Goad (1994:10-11) (cf. default rules in Archangeli 1984, see II.4.1). In contrast, only the inventory is required for contrastive specification, that is, the child needs to know the contrasts between the segments in his inventory.

(1988:193) are the default rules and the first to be applied by the child. This, then, would account for the cross-linguistic similarities in early acquisition data, underlining the universal acquisition scenario.

Before looking at default rules and underlying (underspecified) representation in the context of early phonological acquisition, however, more fundamental questions need to be addressed. With regard to the specification of place, a basic question is whether underspecification is a characteristic of the acquisition process. If this is the case, is underspecification present at birth or learned?; does the underspecified feature retain the same identity throughout the development from early to adult phonology?; etc. The place component coronal has been the subject of discussion regarding both language acquisition and adult phonology, and is generally assumed to be underspecified. Under this hypothesis, the question whether the status of coronal remains the same throughout the development of segmental specification arises even more urgently. Namely, non-specification of coronal would predict coronal to be realised first, and this is not reported to be the case.

#### 4.2 Underspecification in acquisition literature

The role of underspecification and the identity of the underspecified information is discussed here in relation to the acquisition of the phonological component, and as reported in the literature.<sup>4</sup> Stemberger and Stoel-Gammon (1991) is widely quoted as an advocate for radical underspecification of the monovalent place feature coronal. They extend this claim to child language. Rice and Avery (1995) present a notational, geometrical model that is specifically intended to provide for both underspecification and the acquisition of segmental representation. These articles are evaluated in detail with respect to their claims regarding early child language

<sup>4</sup> The short discussion in Ingram (1995) regarding underspecification is not discussed here. It is argued that the learnability of a linguistic analysis can be assessed by studying acquisition data in the light of the analysis (1995:73). The underspecification example, on basis of which Ingram (1995) discusses his model, applies to a 'hypothesised set of acquisition data' (1995:78). The Wichchamni vowels and redundancy rules (Archangeli 1985) are proposed to have four stages in acquisition (stage 4 representing the adult vowels) (Ingram 1995:75):

- |    |   |   |   |   |   |
|----|---|---|---|---|---|
| 1. | i | i | i | i | a |
| 2. | i | i | u | u | a |
| 3. | i | i | u | o | a |
| 4. | i | y | u | o | a |

On basis of the hypothetical nature of these stages, it is not considered appropriate to discuss the example on a par with genuine child language observations.

(4.2.1 and 4.2.2, respectively). The supporting evidence quoted as part of these claims is also investigated (4.2.3). Furthermore, the proposals in Levelt (1994) and Fikkert (1994) are discussed in as far as they relate to underspecification (4.2.4).

#### 4.2.1 *Stemberger and Stoel-Gammon (1991): underspecification of coronal*

According to Stemberger and Stoel-Gammon (1991), the different pattern of behaviour observed for coronals (1991:181-82) can not be accounted for on the basis of performance factors, such as phone frequency and order of acquisition. They suggest that coronal is underspecified in performance (1991:182-83). The evidence from child language, provided by the coronals in child language, is relevant to the discussion here. This evidence in Stemberger and Stoel-Gammon (1991) is presented and discussed in 4.2.1.1-3.

##### 4.2.1.1 Evidence for the special status of coronal

Three different types of evidence are presented *a priori* in favour of coronal underspecification in Stemberger and Stoel-Gammon (1991):

#### (4)

##### i. *relative order of acquisition*

When assessing acquisition order, coronal does not provide evidence for its "special status" in comparison to the other two main places of articulation, labial and velar. This finding is based on studies that state that alveolars and labials are not different in any position in the syllable with regard to the order of acquisition (1991:188).<sup>5</sup>

##### ii. *behaviour in harmony processes*

The literature sources quoted in Stemberger and Stoel-Gammon (1991:189) concerning coronals in harmony processes during acquisition present a varied outcome: no biases in consonant harmony, a bias towards sounds that have been learned earlier, alveolars assimilate to labials and velars, weak consonants assimilate to strong consonants (with reference to a strength hierarchy of consonants).<sup>6</sup> It is argued that examination of data of many children is preferable over the single-subject studies reported. The bulk of the harmony evidence presented consists of a test, performed by the authors, which involves a number of

<sup>5</sup> The studies quoted are: Stoel-Gammon (1985:509); and Vihman, Ferguson and Elbert (1986:26). See II4.2.3 below for a discussion of these references.

<sup>6</sup> For a discussion on consonant harmony, see I6..

children (1991:189-91). Namely, the output of two groups of children is studied, and their harmony and non-assimilatory processes are recorded. The latter type of processes are seen in cases where, for instance, velar is replaced everywhere by alveolar. This is considered velar fronting. The two groups of subjects are i) 33 children studied between 9-24 months (Stoel-Gammon 1985, see 4.2.3.3), and ii) 18 children from various literature sources and unpublished diary studies. The findings in Stemberger and Stoel-Gammon (1991:190-91) on basis of these data are the following:

1. a strong bias towards replacing velars with alveolars in non-assimilatory processes.
2. a bias towards replacing alveolars with velars in harmony.
3. a bias towards replacing alveolars with labials in harmony.
4. the assimilation of velar to labial is as likely as *vice versa*.

The conclusion drawn from these findings is that alveolars behave differently from other places of articulation. An explanation for this special status is discussed in 4.2.1.2.

### iii. *fusions*

Fusion is the phenomenon where two adjacent consonants merge into one consonant. The data observation that the initial consonant cluster /sp/ is realised as [f] (for instance *spot* realised as [fat]), in combination with the absence of a [t] realisation of this target, is accounted for by assuming that the specified features of the two consonants are combined. So, in "the child's" /sp/, /s/ is specified for manner and /p/ is specified for labial, resulting in [f], and thus providing an argument in favour of the coronal underspecification in child language (1991:191).

#### 4.2.1.2 Explanation

Stemberger and Stoel-Gammon (1991) conclude that the findings based on adult and child language point to coronals as the deviant place of articulation (1991:191). The explanation for this finding can not be found in order of acquisition (alveolars and labials are acquired at the same time), nor in the frequency of the consonants of different place of articulation (a bias towards less frequent phonemes is required when it concerns the interaction of alveolar with other places of articulation, and a bias towards more frequent phonemes when labial and velar interact), nor in markedness alone (a bias towards more marked phonemes to account for alveolars, a bias towards

less marked phonemes regarding labials and velars) (1991:192-94). As none of the alternatives provides an adequate explanation for the findings that coronal has a special status among the three main places of articulation, it is claimed that underspecification can account for this, and coronals are concluded to be the underspecified place of articulation.

Concerning the explanation for this underspecification phenomenon several options are presented (1991:193):

- a. 'if it underlies the presence of phonological underspecification in the language system' (1991:193), phone frequency may indirectly account for the status of coronals; through underspecification, a system can be biased towards more frequent phonemes.
- b. phone frequency in prelinguistic babbling, during which period it is claimed that coronals are the most common place of articulation.
- c. the underspecified value<sup>7</sup> is observable in adult speech by children. (This option is regarded as 'improbable' (1991:193) as it entails the assumption that 18-months old children acquire such knowledge from the speech signal.)
- d. underspecification of coronal is innate.

One of these options, namely a., is favoured by the authors, none is conclusively presented.

#### 4.2.1.3 Discussion of the evidence

The evidence from the study of language acquisition, presented in Stemberger and Stoel-Gammon (1991), in support of coronal underspecification is not overwhelming. Of the three types of evidence discussed, relative order of acquisition does not provide a decisive answer. The conclusion drawn on the basis of behaviour in harmony processes supports the different behaviour of coronals with regard to labials and velars. However, it does not become clear (neither from text, nor from Vihman 1978:289) why consistent replacement of velar by alveolar is classified velar fronting, whereas cases that are less consistent are regarded as assimilation processes (Stemberger and Stoel-Gammon 1991:190). For a discussion of the evidence quoted (4.2.1.1i.) and material used (ii.), see 4.2.3. Fusion (iii.) also provides support for the underspecification

<sup>7</sup> The use of *value* is confusing here, as place of articulation is referred to in terms of monovalent features, and *value* generally refers to '+' and '-' of binary features.

hypothesis. However, it appears to concern a minor phenomenon, and no information is provided on the realisation of other, comparable clusters.

In some children's speech in the ChildPhon database, the /sp/ cluster reported on in Stemberger and Stoel-Gammon (1991) in relation to fusion is realised as follows:

(5)	a.	<i>spijkers</i>	'nails'	[tɛitɪs]	/speikərs/	4	#9
	b.	<i>speeltuín</i>	'playground'	[ˈpœyt̪ ˈpeɪ̯tœyn]	/spel̪tœyn/	4	#7
	c.	<i>spiegel</i>	'mirror'	[ˈhiχo]	/spiχəl/	8	#22
	d.	<i>springen</i>	'to jump'	[ˈspɪnə]	/sprɪŋə/	9	#19
	e.	<i>soep</i>	'soup'	[ˈfup]	/sup/	2	#16

Of the examples above, (5a.) presents a similar example of fusion to the one reported by Stemberger and Stoel-Gammon (1991) for the /sp/ cluster. However, the realisation is different; the categorial quality of the /p/ combines with the articulatory quality of the /s/, resulting in [t].<sup>8</sup> This would not support underspecification for coronal in /s/. Moreover, the /sp/ cluster is also realised as [p] by the same child, and as [h]<sup>9</sup> and [sp] (b.-d.). For this last realisation, it could be argued that the child has now sufficiently mastered the /sp/ cluster. Presumably, the children studied in Stemberger and Stoel-Gammon (1991) are at some point also (assumed to be) able to produce /sp/.

When a child speaks like an adult and is capable of pronouncing a target in adult fashion, the mechanism that is to explain the assimilation phenomena characterising child language and/or earlier realisations of the same target is assumed to be no longer valid in the child's system. In the context of Stemberger and Stoel-Gammon (1991), this would mean that, when the child can produce an /sp/ cluster, coronal underspecification is no longer present and coronal is no longer underspecified. The transition of assimilation to coronal (child language), to the absence of assimilation in a similar environment (adult language) and, in particular, the representation of coronal is not addressed.<sup>10</sup>

<sup>8</sup> The [f] realisation is reported to occur significantly more often than a realisation as [t] (Stemberger and Stoel-Gammon 1991:191). However, no account is given for the [t] realisation as such.

<sup>9</sup> Here, the cluster is not realised articulatorily; it is assumed that a dummy consonant, [h], has been produced (see II6.3).

<sup>10</sup> For a rare comment on this, see the discussion of Fikkert (1994) in II4.2.4.



The [f] realisation in (5e.) would render both /sp/ cluster and /s/ similar to the child as far as his target references is concerned, cf. *spot* [fot] (4.2.1.1iii.) (assuming a consonantal scope).<sup>11</sup> The examples in (5) shed a different, less clear light on the third type of evidence provided in Stemberger and Stoel-Gammon (1991), and the scope of the information provided with the data appears rather limited.

For all the points made by Stemberger and Stoel-Gammon (1991) in relation to child language, it is objected to here that the information provided and the claims made are done so outwith the context of the phonological systems of the children concerned. The actual system of phonological contrasts is not mentioned. Their relevance is paramount, as becomes clear from the discussion on the development of place specification (see 5.). Also, the behaviour of coronals during language acquisition and in adult language is treated on a par. With regard to phone frequency as well as markedness, there is no acknowledgement that the vocabulary and/or the status of phonemes in the child's lexicon versus the adult's might be different. No mentioning is made of an investigation of child vocabulary to confirm that the phone frequency claims are valid for both sets of data used in their underspecification argument.

#### 4.2.2 *Rice and Avery (1995): geometrical underspecification in segmental acquisition*

The acquisition of segmental representations is regarded as 'the elaboration of [geometrical] segment structure along a predetermined pathway' (1995:24) in Rice and Avery (1995). This elaboration is to account for the variability as well as the uniformity observed in child language (1995:25). In 4.2.2.1, the principles underlying this model are outlined. Subsequently, the claims concerning variability and characterisation of place of articulation are discussed (4.2.2.2 and 4.2.2.3, respectively).

##### 4.2.2.1 Model

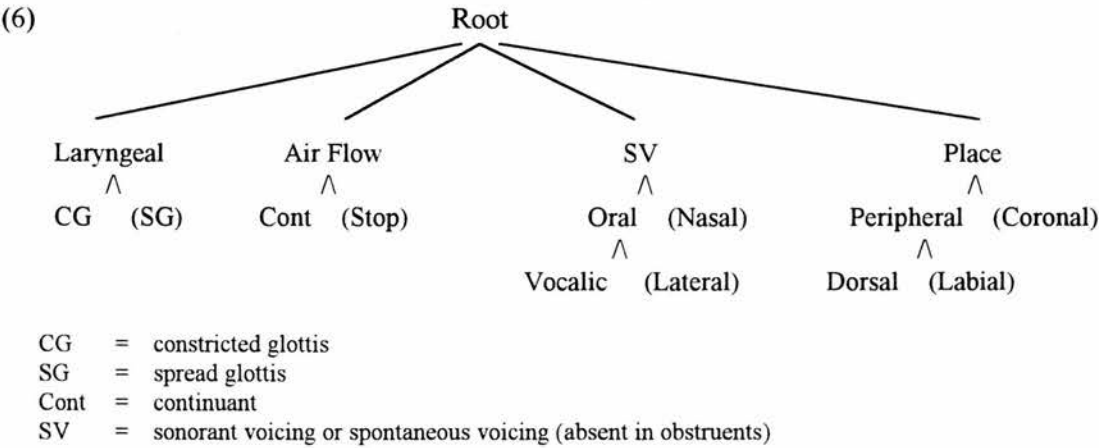
In Rice and Avery (1995), segments are represented according to the minimal specification approach that is adopted as part of the language acquisition proposal therein. Rather than assuming that the child starts off with a full specification of which the redundant features are

<sup>11</sup> The account provided here relates to the lack of contrast between alveolar and velar consonants. Only labial stops and fricatives are stabilised (for Robin 2: #16), and are specified for place of articulation. The round vowel can thus fill-in the non-contrastively non-specified initial consonant slot as far as its articulatory specification is concerned.



deleted once the contrasts in the underlying system have been acquired (full specification approach), his system is regarded as having just sufficient specification as is necessary to keep the segments of the system distinct (1995:24). Initially, phonological structure is ‘relatively impoverished, with little or no structure’ (1995:30). In order to decide on the required minimal segment specification, knowledge of the entire phoneme inventory of the child is required. When more segments are acquired by the child, more contrasts are introduced in the system, constituting positive phonological evidence (1995:30), and a more elaborate specification is consequently required for the segments present (1995:24). Contrast is also responsible for a great deal of variation in the child’s output (see 4.2.2.2), and can be regarded as a central notion of the Rice and Avery proposal.

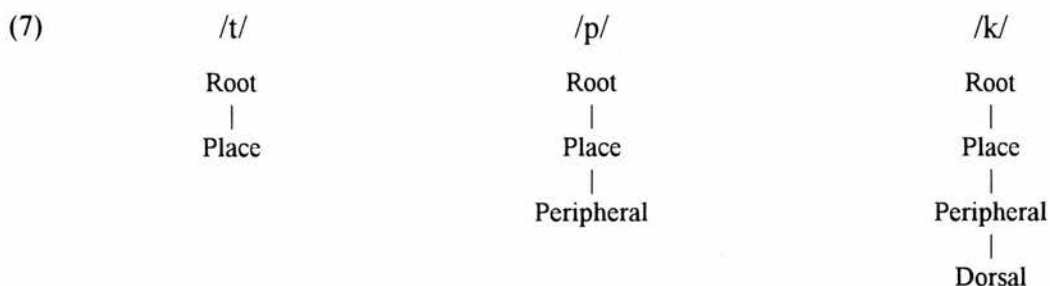
The model proposed is to reflect the course of phonological development, and crucially employs the notion of underspecification (1995:31):



In accordance with the underspecification assumption proper, redundant information is not specified underlyingly. Features that are considered redundant are given between parentheses. As becomes clear from the model (6), at each bifurcation one feature is redundant and one feature is not. Redundancy appears to be related to markedness, which is defined as ‘absence of unmarked features in the phonology’ (1995:33). For instance, nasal is stated to be unmarked, and thus the specification for nasal is absent from the underlying representation.

The unmarked features are default features added for the purposes of phonetic implementation and, in general, do not play a role in the phonology (1995:31).

Following this model and these principles (“unmarked is redundant”, “redundant is not specified”), the representation of the three main places of articulation is as follows (1995:32):



/t/ does not have a dependent under the place node; the coronal node is received by default rule.<sup>12</sup>

The model proposed in Rice and Avery (1995) presents a learning path for the child engaged in phonological acquisition that is based on elaboration and contrast/variability (cf. Ferguson and Farwell 1975:435). ‘Segment structure is elaborated in a monotonic fashion, with the starting point set at completely unmarked [, minimal] structure’ (Rice and Avery 1995:35). The introduction of newly acquired contrasts in the system gives rise to monotonical expansion of the structure, i.e. the ‘addition of structure proceeds a single step at a time’ (1995:35), i.e. a single node at a time. For instance, with regard to the characterisation of place of articulation, the absence of an articulatory opposition in combination with the minimality requirement results in a bare place node (or even the absence of this node) (1995:35).

The introduction of a place contrast involves a distinction below Place, and the Place node is obligatorily present on the unmarked segment, whereas the segment with which it contrasts has a Peripheral node. A further distinction causes the addition of the Dorsal node. This is the only pathway available in the acquisition of the three basic places of articulation; that is, addition of structure proceeds a single step at a time ... . Thus, it must be the case that the first place contrast is between coronal and noncoronal. The next contrast differentiates the noncoronal places of articulation. The normal implementation of this is a coronal/labial/velar distinction.

<sup>12</sup> This is further restricted in the following way: ‘... in languages without distinctions under the Coronal node the feature Coronal is absent underlyingly, whereas in languages with distinctive places of articulation within the coronal range [e.g. retroflex, palatal], the Coronal node must be present underlyingly for all contrasting coronals’ (Rice and Avery 1995:34). As it is assumed that these sub-coronal contrasts are only relevant to the specification of the child’s phonological system much later in the acquisition process, the characterisation of [t] will be assumed to be as given above for the discussion here.

Variability (4.2.2.2) and the relative order of acquisition of place of articulation (4.2.2.3) are issues related to the elaboration of segmental structure in the context of the Rice and Avery proposal.

#### 4.2.2.2 Variability

Two types of variability are mentioned by Rice and Avery (1995) as part of their proposal:

##### i. *non-contrastive variability*

Before a contrast is established between, for example,  $a_1$  and  $a_2$ , the realisation of the “source” segment  $a$  encompasses the ranges of phonetic realisation of both  $a_1$  and  $a_2$  in a fuller specified system. Having fewer contrasts in a system implies that the phonetic space available for the free variants of a particular phoneme in that system is more comprehensive.

This appears to be a general, theoretical claim regarding phonology. Phonological structure is considered minimally specified, i.e. non-contrastive information is not represented. This is included in proposals on “adult” phonology as well, e.g. American structuralism (see Ferguson and Farwell 1975), dependency phonology (Anderson and Ewen 1987), the Prague School notion of archiphoneme (see Rice and Avery 1991a). For instance, an archiphoneme is an element that is ‘identical with the subset of features common to a pair of phonemes whose opposition is neutralised in some positions’ (Anderson, S.R. 1985:107). However, in the child, this aspect of phonology is encountered in an extreme form, caused by the still modest development of his system (see Heijkoop 1993).

Interestingly, the examples presented in Rice and Avery (1995) to illustrate this kind of variability do not go beyond the establishment of the first contrast on a particular “main node”. For instance, non-contrastive variability concerning manner (SV node) in Rice and Avery (1995) is between stop and continuant, and concerning place variation (Place node) between all places of articulation.<sup>13</sup>

<sup>13</sup> Where the three-place-variability is biased towards labial or velar, the influence of the preceding vowel is pointed out (Rice and Avery 1995:37). This could be interpreted as (an illustration of) a filling-in scenario where a non-specified segment receives its place specification from surrounding segments.

ii. *structural variability*

An implication of the geometrical model being discussed here is that, at the moment when the child's system is still 'relatively impoverished' (1995:30), there are several learning paths open to the child as there are several organising nodes that can be elaborated.

Rice and Avery (1995) discuss this phenomenon with regard to the inventories of the languages across the world. They view the acquisition of the phonological system as being comparable to the segmental distribution of these languages (1995:28-29). Their 'model allows inventories to expand in different ways, as it is possible to extend places of articulation and manners of articulation independently' (1995:36). The number of different ways to expand is structurally limited as 'a well-defined path must be satisfied before further elaboration is allowed' (1995:36). As a consequence, it is claimed, "basic" segments occur first.

In terms of acquisitional variability, this means that a system that has one contrast concerning place of articulation, i.e. between coronal and non-coronal would show the following variable realisations: '/p~b~m/ versus /t~d~n/, with perhaps other variants as well' (1995:39). Expansion of place structure with a dorsal node would induce contrastive phonemes grouped or phoneme groups composed as follows: /p~b~m/, /t~d~n/ and /k~g~ŋ/ (1995:40).<sup>14</sup> A subsequently established contrast under the SV node would give /p~b/ /t~d/ /k~g/ and /m/ /n/ /ŋ/. A child who had expanded the SV node before establishing more structure under the place node beyond coronal versus non-coronal, would have a system with different interphonemic relations: /p~b/ /t~d/ /m/ /n/ (1995:38-41). The options that are open for structure expansion are chosen in a different order by different children, and are responsible for inter-child structural variation.

With reference to the explanatory examples provided in Rice and Avery (1995), it does not become overtly clear that variability is regarded as a phenomenon that does not mainly concern the main nodes in a geometry model. For instance, in the case of individual preference, variability is also expected to continue beyond the CV contrast. The preferred sibilant fricatives and affricates realised by T, a Ferguson and Farwell (1975) subject (cf. Ferguson and Farwell 1975:436, discussion data of T), however, are regarded to be variable realisations of the bare

<sup>14</sup> An over-neat picture appears to be presented here as the non-contrastive variability, discussed under i., is not implemented. Non-contrastiveness and the subsequent phonetically "freer" realisations of the phonemes in a limitedly specified system do not seem to go beyond the root node in Rice and Avery (1995).

place node only (Rice and Avery 1995:41). The phone tree of T (on basis of which T's preference has been established, Ferguson and Farwell 1975:426) appears to indicate that the labial and possibly the velar places of articulation are in contrast with alveolar at the time that the child's preference is still noticeable in his output. (As little or no background information is provided regarding the actual utterances and target words of the child, no conclusions can be drawn from the phone trees for the purposes pursued here, namely tracing phonological contrast in the child's system.) It is not in line with the general view of variability to exclude variant realisations of a phoneme that forms a contrast beyond the initial place or manner node. It appears to be a specially implemented limitation in Rice and Avery (1995) to regard variability as a phenomenon that mainly concerns only the main nodes in a geometry model.

The variability reported in the Ferguson and Farwell example discussed above is accounted for by a bare place node (1995:41). 'The introduction of a place contrast involves a distinction *below* Place' (emphasis mine) (1995:35). The lack of place contrast could also be represented by the absence of the place node itself (1995:35). How/when this is the case does not become clear.<sup>15</sup> Assuming the absence of the place node, this optionality seems to clash with the monotonicity principle as formulated by Rice and Avery (1995); a place contrast would involve elaboration of the node as well as a specification below place.<sup>16</sup> Note also that it is stated earlier that the place node, that is obligatorily present on the unmarked, coronal segment (1995:35) is interpreted as /t/ as it receives a coronal node by default rule (1995:32). Within the model proposed, there thus seem to be different interpretations of the bare place node. In adults, it represents a coronal (default rule), whereas during the acquisition process, it accounts for variable realisations. This difference could be explained by the acquisition of the redundancy rule by the child in the course of the process of phonological acquisition.<sup>17</sup> This would imply that coronal is not initially the unmarked value.<sup>18</sup> Still, the model does not offer a uniform treatment for adult and child segment

<sup>15</sup> Given that the place node is optionally specified, the question that arises is how the place node is justified in terms of Clements (1985), namely the motivation of a node on the basis of (a set of) features that consistently behave as a unit (see III1.3 and III3.1).

<sup>16</sup> In general, feature geometry would assume here that the specification of the coronal node would automatically posit the presence of the intervening place node as the presence of a subordinate feature entails the presence of the superordinate feature (McCarthy 1988:98).

<sup>17</sup> This then poses the question whether cost-free Universal Grammar rules need to be acquired by the child, following the definition in Archangeli (1984).

<sup>18</sup> Kenstowicz (1994:519) states that 'there is a slight inconsistency in the underspecification approach to the coronal syndrome: some properties require a bare Place node ... while others seem to call for

specification, which appears to be in disagreement with Rice and Avery's (1995) goal (see 4.2.2.4).

#### 4.2.2.3 Place of articulation

With regard to the feature geometry presented, the design of structure under the place node and the SV (sonorant voicing) node are motivated by assimilation processes in adult language (cf. Rice and Avery 1991b, Avery and Rice 1989), according to the principle that '[a] segment with less structure under SV or Place can assimilate to one with more such structure, whereas one with more structure does not assimilate to one with less structure' (Rice and Avery 1995:32). The model thus principally predicts that coronals assimilate to other places of articulation, and not *vice versa* (see 4.2.2.1):

When structures such as [the ones in (7)] are considered, it is apparent that the difference between places of articulation lies in the amount of specified structure present: Coronals have only a Place node, labials have one node in addition to the Place node, and dorsals have yet an additional node (1995:35).

This is in agreement with the claim generally made concerning place assimilation during the acquisition process (leaving aside the relation between labials and velars). Under the assumption that coronal is underspecified, the structure here can account for the deviant behaviour of coronal (cf. Stemberger and Stoel-Gammon 1991). Another consequence of the structure proposed, however, is the following (Rice and Avery 1995:34):

What is crucial to our theory is the prediction that the first distinction with respect to place of articulation will be between a coronal and a peripheral, a distinction that should be between /t/ and /p/. It seems that this prediction is in general borne out. (See, for example, Ferguson and Farwell, 1975, who stated that the three children they studied had "labial and alveolar stops as their first sounds" [p. 435].).

So, coronal is predicted to be in contrast with non-coronal, i.e. labial and velar.<sup>19</sup> This situation, however, is not encountered in the ChildPhon data analysed. There, the first contrast established is

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no Place specification at all.' This seems to point to the possibility that the discrepancy in the Rice and Avery (1995) proposal is due to the assumption of coronal underspecification as such.

<sup>19</sup> Note that Rice (1996), in a discussion on variability within the context of a similar notational model, adopts the following acquisitional scenario for place of articulation (1996:4, Figure 6):

	<i>place structure</i>	<i>possible realisations</i>
i. single place	Place	any place
ii. two distinctive places	Place <u>and</u> Place-Peripheral	coronal/dorsal <u>and</u> labial
iii. three distinctive places	Place <u>and</u> Place-Peripheral <u>and</u> Place-Peripheral-Dorsal	coronal <u>and</u> labial <u>and</u> dorsal



between labial and non-labial (see 5. for a discussion on the acquisition of place of articulation, and 3.). The latter group contains alveolar and velar realisations. The split between coronal and the rest borne out by the Rice and Avery (1995) model, that is coronal is established first, is not illustrated by the data. Note that Levelt (1994:81) adopts a similar approach to the one in Rice and Avery (1995); until the occurrence of dorsal consonants in the child's output, there are either coronal or non-coronal sounds in his output (the latter characterised as labial). Alternatively, Ferguson and Farwell (1975:435) consider both /t/ and /k/ words to belong to one phone class. This /t~k/ alternation is also observed in the ChildPhon data.

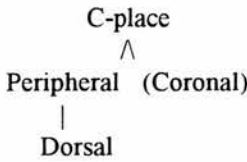
With respect to the expression of markedness in terms of universal distribution by means of segmental complexity, it is interesting to note that, in terms of amount of structure, the model here also ascribes most structure to velar, of the three main places of articulation (cf. Anderson and Ewen 1987). However, the predictions *during* the acquisition of the geometrical model in Rice and Avery (1995) and the learning path available to the child are not in agreement with the findings based on the ChildPhon data.

#### 4.2.2.4 Conclusion

The proposal in Rice and Avery (1995) has been discussed elaborately here as it presents a model discussed with the process of phonological acquisition in mind, and with the ambition to represent both child and adult language uniformly by means of one system of representation. This combination constitutes the motivation behind the notational system, and, although philosophically not novel, a detailed implementation of it is rare. Also, this proposal discusses a number of notions that, although not original or newly introduced, are not often spelled out (e.g. minimal v. full specification approach, relative specification for which the full inventory is taken into account, structural variability, non-contrastive variability). A number of these notions, albeit not in the form in which they are implemented in this model of representation, are also part of the assumptions underlying the proposal outlined in this thesis.

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The interpretation of stage *ii.* is considered here to be confusing; in the place contrast peripheral v. non-peripheral (1996:3), dorsal is classified as non-peripheral, i.e. not non-coronal. However, on the basis of the representation in *iii.* and the model proposed, namely: (1996:2; cf. II3. Figure 7), dorsal is clearly characterised by Peripheral, and is expected to group with labial.



Despite the inherent interest of the Rice and Avery (1995) proposal, several problematic issues arise in relation to the acquisition process that make it less attractive. The interpretation of the place node is different for adult and child representation: a default coronal interpretation versus variable realisations motivated by the absence of structure, respectively. No mentioning is made on how the child gets into possession of the redundancy rule filling a non-specified place node with coronal. Variability in the child's output, both structural and non-contrastive, is adopted as part of the proposal. However, it appears to be mainly limited to the level of the main nodes (SV and Place), contrary to general assumptions. Besides the detailed discussion on variability, the ultimate position adopted is in line with a deterministic view on language acquisition, expressed by means of the learning paths open to the child in the geometrical model proposed. The model posits the prediction that the first articulatory contrast in the child's system is one between coronal on the one hand, and non-coronal on the other. This is not observed in the ChildPhon data, which thus appears to disprove the segmental specification model proposed.

On a more general note, this model seems to illustrate that a) coronal underspecification in a geometrical model and its implication for phonological acquisition do not agree with the actual acquisition of place of articulation, and b) the attempt to capture both adult phenomena and the acquisition process in a geometrical model of representation is not successful, despite the attractive aspect of a limited number of learning paths (see also III3.).

#### 4.2.3 *Quoted evidence*

Ferguson and Farwell (1975); Vihman, Ferguson and Elbert (1986); and Stoel-Gammon (1985) are quoted in support of the proposals in Stemberger and Stoel-Gammon (1991) and/or Rice and Avery (1995) (discussed in 4.2.1 and 4.2.2, respectively). These references are mainly concerned with the relative order of acquisition of place of articulation, and as such they provide evidence regarding the discussion on assimilation and segmental place representation. They are investigated in relation to the actual quotations stated.

##### 4.2.3.1 Ferguson and Farwell (1975)

*quoted in Rice and Avery (1995:34)*

*"labial and alveolar stops are amongst the first sounds"*

The initial consonants of three children are studied (ages between 0;11 and 1;2 at the onset of observations, the number of words acquired between 51 and 72 at the end), and represented in

phone trees. A phone class contains the set of initial phones of words that begin with the same phone or variant phones. Phone classes that contain realisations of the same word are connected with a solid vertical line, connecting corresponding phone classes in different phone trees; related phone classes in successive sessions are connected with dotted vertical lines, constituting a phone tree. The representation resulting from this phone identification and classification is the basis of the findings reported by Ferguson and Farwell (1975). Indeed, they state that '[a]ll three children have labial and alveolar stops as their first sounds ...'. This is an illustration of how the development of the children studied 'follows many of Jakobson's predictions' (75:435). Ferguson and Farwell indicate, however, that this comparison is not completely sound: the similarity is remarked upon '[e]ven though *the phone trees show lexical [i.e. phonetic] contrasts rather than the phonemic contrasts* that Jakobson spoke of ...' (emphasis mine) (1975:435). It may be clear from this that the status of "first sound" of alveolars and labials does not imply a phonological contrast between alveolars and labials, nor that this contrast is the first articulatory contrast to be established. This, in turn, means that the Ferguson and Farwell (1975) study is not an appropriate reference when underlying segmental representation is discussed with regard to the process of phonological acquisition, as is the case in Rice and Avery (1995).

#### 4.2.3.2 Vihman, Ferguson and Elbert (1986)

*quoted in Stemberger and Stoel-Gammon (1991:188)*

*"alveolar and labial place of articulation are acquired at the same time"*

Data from ten children (age 9-16 months) is studied from babbling, i.e. no word use, to a vocabulary of fifty words. This data was analysed from three different approaches:

1. phonetic tendencies in words and babbling; the first "true" consonant in the word (i.e. not glides, glottal stop and [h]) is charted for, amongst other things, place of articulation (labial, dental, velar) and manner of articulation (stop, nasal, fricative, liquid) (Vihman *et al.* 1986:9-10).
2. consonant inventories of words; on the basis of inventories of the phonetic tendencies in words, the emergence of 'a portion of the phonological system with reference in particular to the relationship between babbling and words' is investigated (1986:5). The data was categorised for non-final versus final, and marginal use versus full use (i.e. >4 tokens/session) (1986:10).

3. word selection trees after the phone tree analysis in Ferguson and Farwell (1975) (see 4.2.3.1); the phonological development and the high phonetic variability is investigated by categorising the words under the first, non-final consonant 'of the *adult word* if the consonant occurred in *at least one variant of the word in the child's production* (e.g., [da?: ~ tai ~ kai ~ ga:i] *doggy* ... counts as a D-word)' (Vihman *et al.* 1986:10).

These three separate investigations lead to the following conclusion concerning 'the extent of common tendencies and individual differences in the phonetic productions of [the] subjects': '... there is no clear difference in dominance over time for the labials versus the dentals, though either category alone clearly surpasses the incidence of velars ...' (1986:33). This finding is apparently what Stemberger and Stoel-Gammon (1991) refer to.

Time and time again, the Vihman *et al.* article refers to the variability of 'phonetic preferences and abilities' (1986:35). However much and however obviously this is related to the phonological development, its observation as such is ultimately inconclusive with respect to underlying phonological representation. The only reference to "phonological development" is as follows (1986:36):

Finally, we observed that the phonological processes ... are rooted in the phonetic tendencies of the prelinguistic period.

Phonological development appears to be regarded in terms of phonological processes (cf. '[f]or each of these parameters of the adult language [e.g. (low incidence of) final consonants, consonant clusters, fricatives and liquids] there is a characteristic corresponding phonological process applied by children' (1986:31)). The use of phonological process here goes back to Grunwell (Grunwell 1981a). Besides the undesirability of phonological processes to account for the acquisition process (see I4.1), no illustration is given of how phonological processes are responsible for phonological development.<sup>20</sup>

With regard to the evidence in support of the Stemberger and Stoel-Gammon (1991) assumption that labials and alveolars appear at the same time, it becomes clear from the discussion above that

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<sup>20</sup> The contents of this article provide a strong argument in favour of changing its title so that it does not include 'phonological development'.

this claim is made on phonetic grounds only. It can therefore not be regarded as an appropriate argument in the discussion on coronal underlying underspecification.

#### 4.2.3.3 Stoel-Gammon (1985)

*quoted in Stemberger and Stoel-Gammon (1991:188)*

*"alveolar and labial place of articulation are acquired at the same time"*

The consonantal phones in the utterances of 34 children were analysed (samples taken at 15, 18, 21 and 24 months) to determine the range (word-initial v. word-final) and type (Stoel-Gammon 1985:505). The findings are expressed in terms of implicational statements (1985:507). Regarding place of articulation within initial and final position, the following is stated (1985:507-8):

- i. the presence of a velar phone in initial position implies the presence of both a labial and a velar phone
  - ii. in final position, the presence of a velar phone implies the presence of an alveolar phone
  - iii. in final position, the presence of a velar phone implies the presence of a labial phone\*
  - iv. in final position, the presence of a labial phone implies the presence of an alveolar phone\*
- (\* not statistically significant)

The question concerned, however, whether Stoel-Gammon (1985) actually provides appropriate evidence for the claim that underlyingly alveolar and labial are specified at the same time, is clearly answered by the article itself (1985:511), where again Jakobson's acquisition theory functions as touchstone:

There are ... important theoretical differences between the present findings and Jakobson's theory of phonological development. Most importantly, throughout his monograph, Jakobson was referring to phonemic acquisition and to the order of acquisition of oppositions between phonemes. In contrast, the present study focused entirely on the occurrence of phones rather than phonemes and made no attempt to determine whether the phones function as contrastive units within a child's system.

This settles the question clearly. It can be concluded that Stoel-Gammon (1985) is not an appropriate reference in the discussion regarding coronal underspecification as this concerns underlying representation, nor does it provide sound evidence for assimilation processes in the absence of information about the phonological contrasts that are valid at the time of assimilation, for each child (see 4.2.1.3).

#### 4.2.4 Levelt (1994) and Fikkert (1994)

Underspecification performs a key-role in the account of the acquisition of place features presented in Levelt (1994). Articulatorily unspecified segments in underlying representation are assumed to be realised as coronal. Unfortunately, no motivation is given for this assumption. It is merely stated that

[an] ... assumption is that Coronal is the default value for Place of Articulation. It is therefore not necessary to specify Coronal in the output representation (1994:81).

Reference is made to Paradis and Prunet (1991a), which mainly concerns adult speech (see 4.2.1 for a discussion of the one article that focuses on coronals in child language, i.e. Stemberger and Stoel-Gammon (1991)). The underspecification of coronal, as presented in Levelt (1994), thus appears to be considered to be universal, i.e. in accordance with markedness theory and not with underspecification theory as outlined in Archangeli (1984, 1988), if not *ad hoc*.

Studying Levelt (1994), it becomes clear that coronal underspecification is at the root of several problematic aspects in this proposal. For instance, with regard to the coronal Consonant-Vowel harmony proposed, the question arises how an underspecified coronal can be the trigger for CV harmony, and how coronal can spread as it is not present underlyingly. With regard to the specification of low vowels, an anomaly seems to arise as /a α/ are represented as both labial as well as non-specified coronal. In the latter case, this causes confusion when [+low] is to be automatically associated with these low vowels, as assumed in Levelt (1994), and the low vowels need to be identified. The choice between the two types of non-specified vowels, i.e. coronal and low vowels, does not appear to be possible on basis of their (non-specified) underlying characterisation. The round vowels also give rise to queries. The representation of round vowels is argued to be labial so as to avoid spreading of [+round] to consonants, which would result in rounded labial consonants that are not part of the Dutch segment inventory. As a consequence of this, however, the representation of the acquisition data and adult language, on the basis of which the notational system has initially been designed, gives rise to a descriptive discrepancy between child and adult language. For a detailed discussion of these aspects, see 2..

Fikkert (1994) makes use of the same database as Levelt (1994) in studying prosodic structure during the acquisition process, and briefly discusses segmental changes. The assimilation scenario adopted is, as far as the basic outline is concerned, similar to that in Stemberger and Stoel-Gammon (1991), and in Rice and Avery (1995): coronal assimilates to labial and dorsal. The



underspecification of coronal is to account for this. 'Because the place node is empty, it is *vulnerable* to assimilation, which has the effect of filling the empty place node' (emphasis mine) (Fikkert 1994:241). Indeed, for the period in which place of articulation assimilation of coronal is less frequent, coronals are stated to have become less vulnerable (1994:243).

The theoretical status of "vulnerable" does not become clear. Moreover, the discussion implies a scale of vulnerability and consequently a scale of (under)specification. As the place component coronal is either present or absent, this does not make sense. Also, the motivation for the change of the assumed vulnerable status is not discussed.

#### 4.3. Conclusion and afterthought

On basis of the assimilation phenomena presented in the acquisition literature discussed here, the identity of the segment that is underlyingly not specified in accordance with underspecification theory, and the motivation on which this identity is established is presented unanimously: coronal (or alveolar) place of articulation is underspecified. Basic questions, i.e. whether underspecification is part of the acquisition process, and whether it is learned or innate, are curiously absent from the articles discussed.

With regard to the motivation of coronal acquisitional underspecification, order of acquisition and assimilation processes form the bulk of the arguments. The evidence for relative order of place of articulation, in the form of references to other articles, appears on the whole to be inappropriate for the underspecification discussion. From the examination of this secondary material, it is concluded that all of these references are concerned with phonetic observations rather than phonological contrasts (4.2.3). The two main articles that conduct their discussion at the phonological level, i.e. Rice and Avery (1995), and Levelt (1994), which could potentially provide substantial evidence in favour of (coronal) underspecification, appear to encounter problems within the models proposed. Coronal underspecification seems to be partially responsible for these difficulties.

In Rice and Avery (1995), structural variability appears not to be adopted beyond the main nodes of their geometry (Place and SV), and the universal order of acquisition predicted (coronal *v.* non-coronal is established before a non-coronal contrast) is not encountered in the ChildPhon data analysed here. Moreover, there is no uniform interpretation of the place node in segmental

specification in adult and child language (see 4.2.2.2-4). For a summary of the problematic consequences of underspecification in Levelt (1994), see 4.2.4.

So, the proposals discussed here that incorporate (coronal) underspecification as part of their account of segmental representation during the acquisition process hinge on phonetic-based arguments that provide inappropriate evidence as phonetic segments can only be assessed phonologically relative to the properties of the entire system (Anderson, S.R. 1985:334). The more detailed phonological models discussed show inherent problems. The influential and powerful theory of underspecification introduced by Archangeli (1984, 1988) has thus not had an equally great impact on language acquisition theory as reflected by the discussion of literature here. Despite the elaborate discussion of relevant literature, most of the questions posed at the beginning of this section have not been answered.

As far as the articles discussed is concerned, the overall uninformative and uninnovative result can be partially explained by the approach taken; the coronal underspecification claim has been adopted from studies on adult language, and has merely been extended to child language.<sup>21</sup> No independent investigation has been launched that includes questions such as whether underspecification is part of the child's system during the acquisition process, whether it is different from adult underspecification, etc. Such questions could at least have been prompted by the basic and general observation that the effect of underspecification on adult and child language has a different scope (cf. Paradis and Prunet 1991b). The observation that the underspecification of coronal appears to be more prominently reflected in the child's realisations in the earlier stages of acquisition comparable to later stages would argue not only against a similar account for adult and child language, but also in favour of a differentiation of stages during phonological acquisition as far as underspecification is concerned (see below).

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<sup>21</sup> Cf. Menn (1980:27): 'a theory devised to account economically for an adult behavior cannot generally account for the acquisition of that behavior. The relation between child and adult is, among other things, the relation between a skilled and an unskilled performer. If the adult produces no unskilled acts, the central theory is unlikely to have a way of modelling the production of unskilled acts ... *Therefore the child cannot be modelled merely as one who possesses a subset of the capacities of the adult*' (emphasis mine).

Coronal underspecification is also rejected in Goad (1996) as part of an account of consonant harmony. She points out the following observation: 'as triggers, coronal consonants must bear coronal and, as targets, they must be unspecified for this feature' (1996:187).<sup>22</sup> This clashes with the assumption of coronal underspecification as such. Coronal is assumed to be unspecified according to contrastive specification only (1996:189), i.e. non-contrastive non-specification, which is in line with the approach taken here. On the basis of the output data in Smith (1973), an alternative to coronal underspecification is proposed, namely a constraint-based analysis within the framework of optimality theory (with reference to Prince and Smolensky 1993) (cf. 6.7).

In Optimality Theory (OT), rules and derivations are rejected in favour of constraints only. "Inputs" (underlying representations) and "outputs" (surface representations) are related through a set of universal, violable constraints. Individual grammars are constructed from this set of constraints only; cross-linguistic variation is thus due to differences in constraint ranking. In the OT literature on acquisition, it is assumed that children's grammars contain the same constraints as do adult languages. At the onset of acquisition, constraints are generally assumed to be ranked in an order which yields unmarked structures ... (Goad 1996:189).

The special status of coronals in consonant harmony is thus accounted for by the ranking of the optimality constraints, which 'capture[s] the fact that coronal are the most common targets in assimilation' (1996:189). Coronal nasals and obstruents are specified for coronal and can thus trigger assimilation. Because of the constraint ranking, however, they can not target labial and dorsal segments. Liquids, however, are not specified for place (liquids are not contrastive for place of articulation (1996:188)), and can thus be subject to coronal assimilation.

In the context of the data discussed here, two aspects of Goad's (1996) account are of direct interest. First, the output of the child that is analysed is characterised as follows: i.) consonant harmony never applies between labial and velars, and ii.) consonant harmony only targets coronals (1996:190). This is clearly not in agreement with the data of the children analysed here. Secondly, the age of the subject in Ingram (1973) with regard to the data focused on is between 2.60 (i.e. two years and 60 days) and 2.114 (Goad 1996:187). It thus concerns a developmental period that is later than and different from the period studied with reference to the ChildPhon and Cruttenden data. On the basis of this information, the study presented in Goad (1996) can be concluded to be not comparable to the study here. Also, there is no indication that the

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<sup>22</sup> A similar objection is raised in the discussion of Levelt (1994) (see II.2.3.1).

phonological representation assumed is based on anything else than phonetic observations (see above).

Another recent study that addresses underspecification is Gierut (1996). Thirty normally developing children between 3;1 and 5;10 (ten children of each age 3, 4, and 5 years) were involved in a free classification task in order to study their conceptual knowledge of phonological categories, namely the labial-coronal contrast, and the continuancy contrast for stops and fricatives (1996:400-401). The main research aims were:

1. to identify which features children use in the categorisation of segmental information.
2. to examine whether the defining features of a category shift as the phonological system advances.
3. to determine the adequacy of contrastive specification v. radical underspecification in accounting for observed patterns of categorisation.

The findings are as follows (1996:410): fricatives are judged minimally along the continuant dimension, /p/ is defined in terms of labiality, /t/ is not defined in terms of featural properties. It is thus concluded that 'a limited set of featural dimensions was used to guide children's judgements of the perceived similarity of segments [and these dimensions are compatible with] those claimed to be nonredundant and more marked in fully developed languages' (1996:410). These findings are concluded to be consistent with the claims of radical underspecification.

It appears that Gierut regards these findings concerning the phonological representation of the children studied as the child's most elaborate system up till that point.

Children apparently work from an initial representation that is sparse in featural information, and elaborate this structure as phonological distinctions of the language are discovered productively (1996:413).

It does not become apparent that she takes into account the possibility that the child has "acquired underspecification", whether in an Archangelian or optimality sense, after all the places of articulation have been established as is strongly suggested by the data studied here. This approach could then incorporate the findings of the analysis proposed here, covering the period 1-2,5 years, namely, the child acquires the major place (and manner) contrasts as well as the conclusion in Gierut (1996) that, between 3-5 years, underspecification is part of the child's phonological representation. An obvious research suggestion is thus whether and when (radical)

underspecification can be concluded on the basis of the data from longitudinal, regularly repeated testing between 2-3 years.

Part of the evidence presented in support of coronal underspecification is represented by assimilation processes (coronal assimilates to labial and velar, not *vice versa*), and is discussed in 5. in terms of phonological development. The discussion on underspecification and acquisition is continued as part of 5., The acquisition of place of articulation (5.7), as well. It is concluded that coronal is not specified for part of the acquisition process on basis of system-internal reasons. Moreover, analysis of the ChildPhon data shows that the child actually has an articulatorily non-specified segment during the early stages of the acquisition process. This segment is identified as glottal stop (see 6.). This finding does not support coronal underspecification.

## 5. The acquisition of place of articulation

### 5.1 Introduction

The observation in early acquisitional data that the place of articulation realisations in the child's output are similar across an utterance and/or that they are different from the articulatory specification of the adult target has been central to the discussion on the nature of child language. Examples are provided in (1).

(1)	a.	<i>koffie</i>	'coffee'	/kɔfi/	[pɔfi]	4 #5
	b.	<i>kijk</i>	'look'	/keik/	[tɛit]	4 #6
	c.	<i>kijk maar</i>	'just look'	/keik 'maɪ/	[teɪmaɪ 'xɛɪmaɪ]	4 #8
	d.	<i>klok</i>	'clock'	/klɔk/	[pɔ:tɔ]	4 #4

Stemberger and Stoel-Gammon (1991) look at place of articulation in relation to harmony processes, amongst other things (see 4.2.1 for a discussion of Stemberger and Stoel-Gammon 1991). Their findings regarding the acquisition period are as follows: i.) a strong bias towards replacing velars with alveolars in non-assimilatory processes, ii.) a bias towards replacing alveolars with velars in harmony, iii.) a bias towards replacing alveolars with labials in harmony, iv.) the assimilation of velar to labial is as likely as *vice versa*. These findings are explained by the assumption of alveolar as the deviant place of articulation. This is structurally expressed by the underspecification of the place component coronal. Coronal underspecification is also assumed in Levelt (1994) where it is the basis for the VC harmony proposal (see 2.). The realisation of place of articulation is argued to result from the interaction between vowels and adjacent consonants.

In this section, the necessity to adopt coronal/alveolar underspecification in order to account for the output in early acquisition regarding place of articulation is evaluated. The data from the ChildPhon database is investigated with regard to the realisation of place of articulation and its relation with the target place specification. The proposal that is outlined here can account for the observed place realisation as a direct consequence of the state of development of the child's phonological system (cf. Heijkoop 1997).



## 5.2 A proposal

### 5.2.1 *Underlying concepts*

The child's phonological system is constituted by the sound contrasts acquired by him as evident in his output. Following Grunwell (1987:37), the basic principles that determine the system of contrastive phonemes are the following:

1. phones which consistently function contrastively to signal meaning differences ... are the contrastive phones.
2. phones which appear to occur in free variation at the same place in structure [are] phones which are non-contrastive variants of a phonologically contrastive phone.

Regarding the second point, the variable realisations of a target phoneme are referred to as non-contrastive variability in the child's system (1987:78). Due to the small number of contrasts present in the child's system during the early stages of phonological acquisition, the phonetic space of each contrastive entity that is available for the realisations of this entity is wide, and also wider than the space available to adult phonemes. Here, it is stressed that this notion is not just applicable to child data. It is a general concept in phonological theory that, because of the child's "incompletely" developed system, is responsible for a greater and more conspicuous proportion of the overall realisations. Neither of the concepts discussed in this section, i.e. non-contrastive variability and filling-in (see below), are unique to (the theory of) child language (cf. 4.2.2). They are merely highlighted as they provide the background for the account of the acquisition data studied that is presented in (5).

The second aspect underlying the proposal here is the process whereby a non-specified segment receives a specification by spreading of or being filled-in by a specification of a segment which is specified for the gesture in question.<sup>1</sup> (This filling-in mechanism will be illustrated in 5.2.3.) Here, the concern is with place of articulation.

### 5.2.2 *System evolution: development of contrasts*

From the early system evolution and the development of phonological entities therein (3.), it becomes apparent that for all children whose data has been analysed, the first articulatory distinction among consonants is between labial and non-labial.<sup>2</sup> This is observed either for oral

<sup>1</sup> For another area where the filling-in process is directly relevant to the child's forms on a phonetic level, see II7.2.2.

<sup>2</sup> Here, the focus will be on the ChildPhon data. The phonological development of the fifth Dutch child, Jarmo (8), will be discussed in detail in II8.3. The development of contrast for this child does

stops (2 #8, 4 #4 and 7 #11) or nasal stops (9 #7). The subsequent articulatory distinction after the contrast established between labial (oral and nasal) stops and non-labial stops (2 #14, 4 #6, 7 #12 and 9 #10) is also between labial and non-labial among non-stops. Namely:

(2)	2	fricative	#15	7	fricative	#16
		liquid	#19		liquid	#20
	4	fricative	#8	9	fricative	#14
		liquid	#8		liquid	#18

When a contrast between labial v. non-labial has been established, for instance, for fricatives, non-labial fricatives are realised as alveolar and/or velar.

So, the overall development in the articulatory gesture, which is of main relevance for the present place of articulation discussion, is between labial and non-labial across the manner of articulation categories distinguished (nasal, stop, fricative and liquid). Subsequently, the non-labial group develops a contrast between alveolar and velar. The phonological system of one the children studied does not give evidence of this contrast as it had not sufficiently developed at the time of the last recording session, namely of Eva (4). For another child, the phonological system only displays the alveolar-velar contrast for a subset of the categorial categories; Robin (2) only has this contrast for the stop and fricative categories. The sessions in which the alveolar-velar contrasts is observed in the output are indicated in (3) for the different manner categories:

(3)	2	#20	stop, fricative	7	#16	oral stop
					#16	fricative
					#21	liquid
	4	-		9	#14	fricative
					#17	oral stop
					#19	liquid

To summarise, in terms of underlying specification, labial is present underlying well before velar and alveolar are specified in the various manner categories, i.e. when the contrast amongst the non-labial segments has stabilised.

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not contradict the data discussed here. The development of the two English children will be discussed in II10.1.

### 5.2.3 *Contrast and realisation*

The interaction between contrast and realisation, i.e. between the contrasts present in a child's phonological system and his realisations of a target word, is illustrated here on basis of the output from Elke (9) and Tom (7). The relevance of the notion of non-contrastive variability and the filling-in mechanism (5.2.1) regarding the child's realisation becomes apparent.

The child realisations from Elke and Tom are presented in (4) with the target word, translation and observation session. Furthermore, the target segment that is focused on here is stated, followed by the relevant contrast as it is present in the child's phonological system (based on the evolution of contrast in the child's system, 3.). In the last column, the account of the actual realisation by the child is given. For instance, *zon* 'sun' /zɔn/ 7 in #21 is realised as [ʃɔm]. With regard to the final alveolar consonant in the target word, the relevant contrast present in the child's phonological system at #21 is labial nasal v. nasal. The child's realisation of [m] for target /n/ can thus be explained as labial filling-in: the final non-specified consonant is realised on basis of the labial specification of the vowel. As becomes clear, the child forms in (4) and their "deviation" from the target word can be accounted for on basis of the contrasts present in the child's system at the time of utterance. Non-contrastive variation and the optional filling-in mechanism provide a simple account for the forms discussed here. It should be noted that the realisations from Tom and Elke straightforwardly are representative of the acquisitional data studied.

In this section, the application of the two underlying concepts (5.2.1) has been shown to interact with the contrasts present in the child's system (5.2.2), and thus explains the realisations observed (5.2.3). In 5.3, a more detailed discussion is presented on basis of the data from Robin (2). This case study further clarifies the relation between contrast and realisation introduced here. It focuses on place of articulation, and specification in the course of the development of Robins's system, namely, before and after contrasts have been established underlyingly.

### 5.3 **Case study: contrast and realisation**

In (5), forms from the data of Robin (2) are presented to illustrate the nature of early acquisitional variability in the child's realisation of place of articulation, in relation to the target word, and also in relation to other realisations of the same target. This variability illustrates the relation between

(4)

target segment      contrast present      account realisation

9

a.	#6	[puk 'pukə]	'buk 'huk]	'ku 'kuk/ 'biscuit, cake'	<i>koek</i> <i>tafel</i>	initial velar stop	(nasal) stop	variable realisation
b.	#12	[pafu 'pafu]	'tafu]	'tafel/ 'table'	<i>tafel</i> <i>kijk</i>	initial alveolar stop	labial stop v. stop	labial filling-in (from labial CV [fu])
c.	#14	['keik 'keik]	'tek 'keik]	'look' <i>een bril</i>	initial and final velar stop	labial stop v. stop	variable realisation non- labials	
d.	#17	[ʔəm'biə]		'(a pair of) glasses'	final alveolar nasal stop	labial nasal v. nasal	labial filling-in (from following labial stop)	

7

e.	#14	[kiku 'kiku]	'tita 'kiku]	<i>kikker</i> 'frog'	initial and medial velar stop	labial stop v. stop	variable realisation non-labials
f.	#10	[pəfəw 'pəfəw]		<i>vogel</i> 'bird'	medial velar fricative	continuant	variable realisation (under influence of preceding labial fricative)
g.	#11	[ʔəw 'ʔəw]		<i>idem</i>	initial labial fricative	continuant	variable realisation (under influence of following velar fricative)
h.	#10	[pim 'pim]		<i>pinguin</i> 'penguin'	final alveolar nasal	nasal	variable realisation
i.	#21	[səm 'səm]		<i>zon</i> 'sun'	final alveolar nasal	labial nasal v. nasal	labial filling-in (from vowel)

contrast and realisation discussed in 5.2. Robin's forms are particularly suitable for this purpose because the contrast between the non-labial categories for stops and fricatives, i.e. the contrast between alveolar and velar place of articulation, stabilises at around the same time, observed in #20. This causes a rather sudden change in the child's output of the relevant group of words regarding place of articulation. The relevance of the early specification of labial is illustrated in relation to the filling-in mechanism (5.2.1).

As the focus of the discussion is on (the development of) place realisation variability, those words that are realised both before and after a contrast are of particular interest here. These only form a small group. Therefore, "individual" forms, i.e. forms that occur on either side of the contrast, are presented to support the "continuous" forms.

In Figure 5, the consecutive phonological systems are given to the left. The recording sessions in the shaded column indicate the time when these are valid. For instance, the phonological system at #6 comprises four contrastive entities: nasal, stop, fricative and liquid. This state of affairs remains unchanged until #8, when the phonological system is characterised by a contrast between labial and non-labial stops.

*Bad* 'bath' /bat/, the first word to the right of the shaded column, illustrates the first articulatory contrast to stabilise in Robin's system. At #5, final target /t/ is realised as a labial stop before the contrast labial stop *v.* stop is present (the contrasts illustrated by the forms given are shaded), and can thus be regarded as an instance of non-contrastive variability. From #8 on, when the stops have a contrast, this realisation would strictly speaking be no longer in accordance with the system (for apparent anomalies, see discussion on *kapitein*, *komen*, *tafel* below). Indeed, in #8, *bad* has a final consonant that is realised within the non-labial "phonetic space", namely as a final alveolar phone.

The next opposition amongst the stops, the contrast alveolar *v.* velar stops, stabilises in #20. Both *clown* 'clown' /klaun/ (*clowntje* 'clown', dim. /klauntjə/) and *kijk* 'look' /kɛik/ are realised before and after #20, and the development of these forms illustrates the development of this contrast in the system. In #8, 10 and #17, both words have an alveolar realisation for target /k/. As this is a non-labial realisation, it satisfies the requirements posited by the system (contrast present: labial stop *v.* stop), and illustrates non-contrastive variability (see below). However, in #22, alveolar and velar are in contrast (contrast present: labial stop *v.* alveolar stop *v.* velar stop).

contrasts

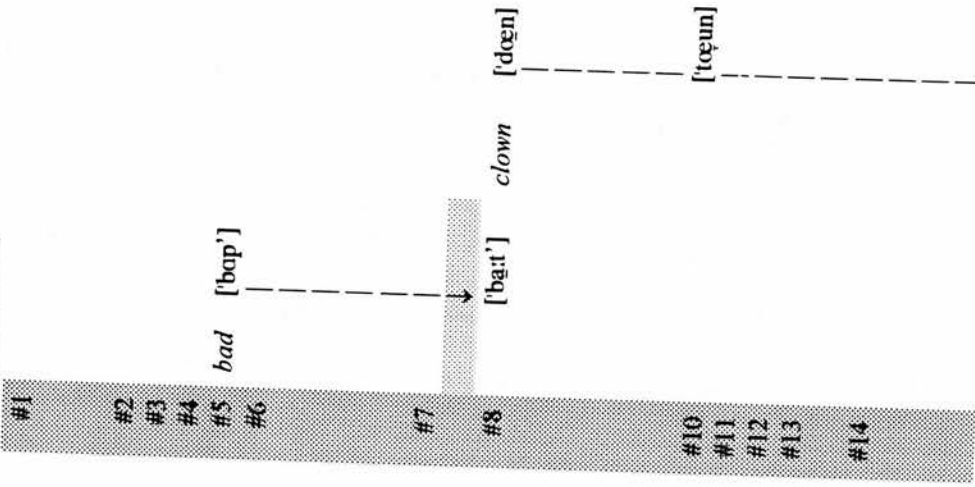
nasal
stop
cont

nasal
stop
fricative
liquid

nasal
lab stop
fricative
liquid

lab
nasal
nasal
stop
lab stop
fricative
liquid

realisations



- (5) Early system evolution of Robin (2)  
 contrasts established on basis of child realisations



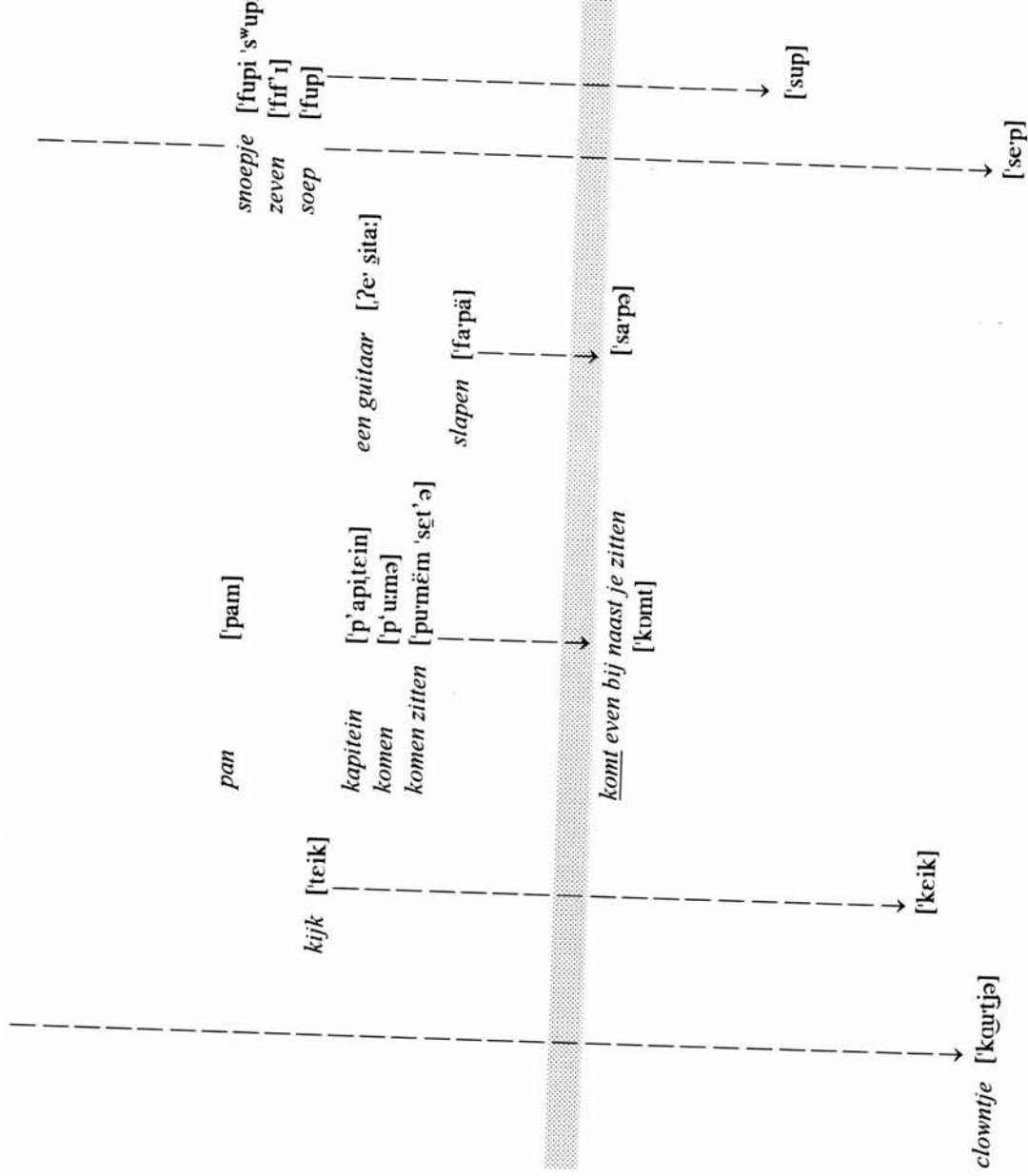
lab	nasal	nasal
lab	stop	stop
lab	fric	fric
liquid		

lab	nasal	nasal
lab	stop	stop
lab	fric	fric
lab	liquid	liquid

lab	nasal	nasal
lab	stop	alv stop
lab	fric	alv fric
lab	liquid	liquid

lab	nasal	alv nasal	vel nasal
lab	stop	alv stop	vel stop
lab	fric	alv fric	vel fric
lab	liquid	liquid	

#15 #16 #17 #18 #19 #20 #21 #22 #23 #24



*Clown*, in its diminutive form, is now realised with an initial velar phone. The realisation of the consonants in *kijk* in #22 is also velar, and thus corresponding phonetically to the adult target.

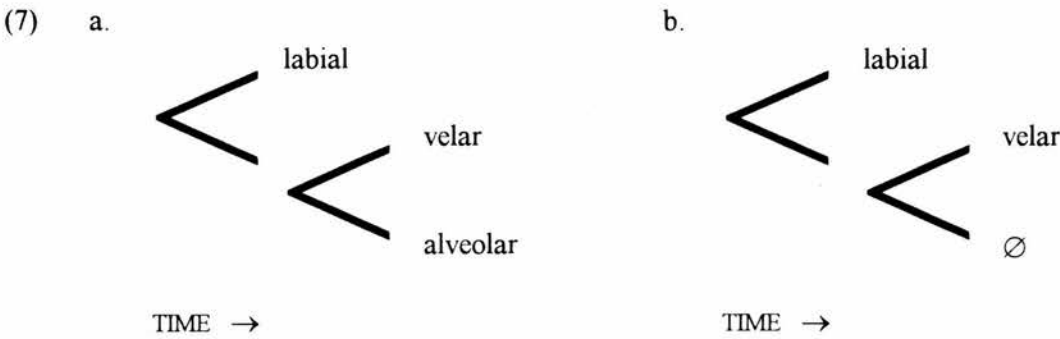
At #18, Figure (5) has three forms that have /k/ in initial target position and a realisation as a labial stop phone. These forms are:

(6)	a.	[p'api:ɛin]	<i>kapitein</i>	'captain'	/kapi'tɛin/
	b.	[p'u:mə]	<i>komen</i>	'to come'	/kɔmə/
	c.	[pʊrmɛm 'sɛt'ə]	<i>komen zitten</i>	'to come and sit'	/kɔmə 'zɪtə/

The phonological system of Robin has an opposition labial stop v. stop at #18. As the phonetic space has been split up into a non-labial and a labial space, the output forms with [p] for target /k/ appear anomalous. At first sight, [p] for /k/ seems to emerge at the wrong side of the divide, and [t] or [k] is expected. On a phonological level, however, [k] does not have a specification (nor does [t]). The labial stops are assumed to be specified for labial, the “rest” is characterised by non-specification. The empty articulatory gesture for initial [k]/[t] is thus assumed to be filled-in by the following labial consonant, and is realised as labial too.

A similar account applies to the realisation of *tafel* and *pan*. At #13, there is no contrast between the non-labial stops. [t] is not specified underlyingly, and the initial consonant slot in *tafel* ‘table’ /tafəl/ is filled in by the labial specification in the articulatory gesture of medial /f/ (see below). In [pam], Robin’s realisation of *pan* ‘pan’ /pan/, the final labial nasal is an articulatory empty nasal underlyingly, on basis of the opposition labial nasal v. nasal that is present at #16, and is thus regarded as filled-in by the initial labial consonant as well.

At #20, the oppositions within the stop category are: labial v. alveolar v. velar. Both alveolar and velar are now underlyingly specified, and a labial filling-in scenario is no longer possible. Indeed, *komt* ‘comes’ /kɔmt/ is realised with an initial velar in *komt even bij naast je zitten* #20. This lack of filling-in evidence, provided its widespread (cf. examples below), points to a sequence of development regarding place specification as presented in (7a.), whilst rejecting the one in (b.).



A similar scenario can account for the child's realisations of fricatives at both side of the watershed. At #20, the phonological system posits a contrast between alveolar and velar. Before #20, alveolar and velar are in the non-labial category of the labial fricatives v. fricatives opposition, and as such not specified. Therefore it is possible for these segments to receive a labial specification from other, specified segments. This accounts for the following forms in Robin's output, amongst others: *snoepje* 'sweet', noun, dim. /snupjə/ (/snupɪ/) #16 ['fupi 'sʷupi](see below), and *zeven* 'seven' /zevən/ #16 ['fif'ɪ].

Labial filling-in is not obligatory, and non-contrastive variability is also encountered. The non-specified, non-labial entity can be realised as either alveolar or velar, namely as in *daar groenteman* 'there greengrocer' /daɪ 'χruntəman/ #14 [sʊɫsəməm], and *een gitaar* 'a guitar' /ən χi'taɪ/ #18 [ʔə 'sita:].

After #20, the opposition amongst the non-labial stops and fricatives, and subsequent articulatory specification of alveolar and velar, makes that labial filling-in is no longer an option. The realisations of *slapen*, *soep* and *zeep* illustrate exactly that.

(8)	a.	<i>slapen</i>	'to sleep'	/slapə/	#19	['fa:pä]	#20	['sa:pe]
	b.	<i>soep</i>	'soup'	/sup/	#16	['fup]	#21	['sup]
	c.	<i>zeep</i>	'soap'	/zep/	#12	['fip]	#23	['se:p]

Robin's realisations of *kijk*, *tafel* and *snoepje* are illustrated below. (The shaded areas indicate what is outside the scope of the discussion here, namely underlying characterisation of vowels. For a discussion on vowel-consonant relations, see III7..)

(9)	a.	<i>kijk</i>			b.	<i>tafel</i>			c.	<i>snoepje</i>				
		[teik]				[pa'fy]				[fupi]/[s'wupi]				
		C	V	C		C	V	C		V	C	V	C	V
		Ø		Ø		Ø		labial		Ø		labial	Ø	
ARTICULATORY gesture														
CATEGORIAL gesture		stop		stop		stop		stop		fricative		stop		

The realisation of *kijk* (9a.) illustrates non-contrastive variability: [t] for /k/, and alveolar can be concluded not to have stabilised yet. This is also true for *tafel*, pronounced as [pa'fy] (9b.). However, this form demonstrates labial filling-in as well (in (9), labial segments are presented in bold, filled-in segments are boxed). The initial slot is not specified on basis of the absence of a contrast between non-labial consonants in the child's system at #13. The structure of *snoepje* entails two elements of choice (9c.). Firstly, the mechanism whereby the initial non-specified fricative receives a labial specification is optional; both initial [f] and [s] occur in Robin's realisations. Furthermore, in case of labial filling-in, the source segment can be from the consonant of the following CV unit, /f/, and/or it can be from the neighbouring labial vowel.

In a few cases of labial filling-in, the categorial specification of the consonant in question is not stable yet. This results in variable manner realisations, whereas the place realisations in the child's output are the same. In the i.-examples in (10), the target cluster alveolar + velar fricative (10a.) and the velar target stop (b.) are realised as fricatives, whereas the ii.-examples have a stop in the child form. On basis of the labial realisations, it can be concluded that all forms lack an articulatory specification for alveolar and velar underlyingly (contrast present: labial v. non-labial).

(10)	a.	i.	#15	[bətə'fap]	<i>boodschappen</i>	'shopping', noun	/bət,sxapə/
		ii.	#15	[bət'papə]	<i>idem</i>		
	b.	i.	#16	[fə'fi]	<i>koffie</i>	'coffee'	/kəfi/
		ii.	#17	[pəfi 'dɪŋkə]	<i>koffie drinken</i>	'to drink coffee'	/kəfi 'dɪŋkə/

The study of variable realisations here also illustrates the important role of the initial C in the CV(CV...) child structure. This is the position that provides the space where the child most actively "practices" to get the, in this case, articulatory value of the target segments right. Whereas the CV(CV...) structure as a whole offers practice space for the child's abilities, the

initial consonantal position illustrates this particularly well, as can be concluded from the child's output (see 7.4).

From the discussion here, it becomes clear that the variability concerning the realisation of place of articulation in the data analysed can be accounted for on the basis of the contrasts in Robin's phonological system. Non-contrastive variability and the labial filling-in of underlyingly non-specified segments results in realisations that are "variable" on a phonetic level with regard to the adult target. On a phonological level, however, these forms are in accordance with the phonological system valid for Robin at the time, and as such simply regular.

## 5.4 Conclusion

### 5.4.1 *Regarding the present proposal*

The consecutive phonological systems that constitute a child's phonological development typically display an increasing number of oppositions. The presence of more phonological entities in the child's lexicon implies that the phonetic space for each of these has become less wide. As a consequence of this development, the variability observed in the child's realisations of words decreases

Initially, within a contrast free system or manner category, free variation is possible for the realisation of place of articulation. As there are no articulatory contrasts in the system yet, unstable segments can be realised "throughout" the phonetic space available.<sup>3</sup> When the stop category, for instance, has a contrast, the fricative (or continuant) category can still display free variation. The first opposition in a phonological system and across all manner categories is between labial and non-labial (see 5.2.2). Target labials are then realised as labials. The variability amongst the non-labials is thus limited to the alveolar-velar space. However, as the non-labials underlyingly do not have a specification in the articulatory gesture at that moment, they can emerge as labial consonants in the child's output; they optionally receive a labial specification from surrounding labial segments.

So, after free variation and the absence of contrast in the phonological system (A), the following stages (B, C) can be discerned for the place categories:

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<sup>3</sup> In some words the realisation of segments appears to be stable before the contrast is established on a system-wide basis (see III.3.4).

- (11) A non-contrastive non-specification before labial establishment: *variable realisations*.  
 B non-contrastive non-specification of non-labial segments after labial establishment: *variable alveolar and velar realisations, labial filling-in of non-labials*.  
 C contrastive specification of the three main places of articulation: *no articulatory variability*.

#### 5.4.2 *Regarding other proposals*

The realisation of place of articulation in the output of the children studied can be straightforwardly explained by taking into consideration the phonological system valid at the time of utterance. The non-specification in the absence of a contrast, and also the early specification of labial, account for the variability observed. In the light of the proposal here, it is concluded that there is no reason to adopt coronal underspecification for the child's underlying system (see 4.). The conclusion/assumption in Stemberger and Stoel-Gammon (1991) and Levelt (1994) is regarded as unnecessary and undesirable. Assessing not the phonetic surface presence of a sound, but the phonological, underlying specification of the child's system throughout its early development points to non-specification of alveolar where necessary (non-contrastive non-specification), and thus renders an account comprising underspecified non-specification void.

The observation regarding assimilation processes in Stemberger and Stoel-Gammon (1991) (see 5.1) can be explained without the need to invoke underspecification, and the subsequent creation of a disparate identity of the effect of underspecification as it accounts for the phenomena of a different nature in adult language and in child language. The phonological system of the child, rather than an external mechanism, provides an explanation for observations concerning place of articulation.

The observed preference of labial over alveolar in the realisation of place of articulation has been shown to be rooted in the early specification of labial. Because of the labial filling-in mechanism, more labial segments are in the child's output than in his underlying representation. The reason for labial to be established first among the three main articulatory specifications is possibly because of its acoustic properties. Labial is by nature more easily perceived, also with respect to its visually more noticeable character (Jakobson 1968:67) and its articulatorily optimal consonantal character (see 7.3).



The core discussion regarding the place specification of consonants in Levelt (1994) centres around the relation between consonants and vowels in the child's utterances. VC harmony and the universal relation between front vowels and coronal consonants, between round vowels and labial consonants, and between back vowels and velar consonants are argued to account for the realisation of place of articulation in early phonological acquisition. With reference to the proposal here, front vowels could indeed motivate the occurrence of an alveolar consonant in realisation. However, only in the case of non-contrastive variability. The relation between labial consonants and vowels is also acknowledged; the labial filling-in mechanism requires a labial segment, for instance a labial vowel.<sup>4</sup> However, in so far as the vowel is the decisive factor with regard to the articulatory nature of the adjacent consonant, this is assumed to be at a phonetic level only. (See discussion on CV relations in III7.)

It is concluded here that regarding the phenomena for which underspecification is evoked (cf. Stemberger and Stoel-Gammon 1991, Levelt 1994), this assumption is not required in order to account for the language acquisition data studied. Underspecification is not observed in the early stages of acquisition (see 4. and 6.7). For part of the child's development, alveolar segments are assumed to be non-specified. However, the source of this non-specification is the absence of contrast.

### 5.5 Again underspecification

As has been shown above (5.2-4), the "deviant" behaviour of coronal during the early stages of acquisition can be regarded as a consequence of the interaction between underlyingly specified and unspecified phonological entities. Which contrasts are established and therefore which entities are specified in a phonological system is a matter that is language specific within the range of "possible" systems (cf. Maddieson 1984), and, in the context of child language, also depends on the development of the individual child's system, again, within possible universal boundaries, e.g. labial priority. The realisations of the longitudinal data of the children analysed here do not provide evidence for coronal underspecification, which can thus be concluded not to be present at

<sup>4</sup> In Levelt (1994:95-96), the representation of "labial filling-in" is varied, depending on the identity of the vowel in the child form: *soep* 'soup' /sup/ [fup] 2 = {WORD, Labial}, and *zeven* 'seven' /zevən/ [fɪf'ɪ] 2 = {[WORD], Labial}. At #16, when these forms were realised, the relevant category, fricative, has a labial v. non-labial contrast.

the onset of speech. In the changing system of the child, non-specification is regarded as a matter of non-contrastiveness rather than a matter of underspecification. The finding that coronal underspecification is not innate supports the invalidity of the tendency to extend processes and theoretical claims from adult language and impose these on acquisition data.

On basis of the data observations, all three place categories are assumed to be specified in the C stage (5.4.1). As observed, underspecification in the Archangelian sense is not evident in the child data, and is thus not regarded as innate. Assuming underspecification as such (see 4.), an alternative proposal for the “acquisition of underspecification” is required. The point in the development of the phonological system in the wider sense at which underspecification is introduced in the underlying specification is to be decided on basis of data from older speakers than the children studied here. Only when their output gives evidence of phenomena of underspecification similar to those discussed in relation to adult language can its presence be concluded. Besides the question regarding the *timing* of this process, the aspects of *how*, *why* and *on what principles* need to be addressed.

Given that underspecification is to be acquired, it needs to be implemented in a phonological system where the (main) articulatory and categorial contrasts are established. A process could be envisaged through which the underspecification mechanism, i.e. predictable information is absent from underlying specification and supplied by rule, is gradually implemented in the system, for instance, through representational redescription (see I4.3). First, however, the “need” for underspecification must be - cognitively - recognised. The motivation to not supply redundant features is assumed to be one of economy. A system that only specifies the minimal amount of information is assumed to function more efficiently and effectively.

The question regarding the principles on which the identity of the non-specified features or feature specifications is based does not receive a (clear-cut) answer in the literature. First of all, the language specific background of underspecification discussed in Archangeli (1984) has somewhat drifted out of focus. Coronal is considered as a non-specified entity on a universal scale (Levelt 1994). This is reminiscent of markedness theory rather than Archangelian underspecification. Also, little or no attention is given to the identity of the accompanying default rules.

Concerning the decision what information not to specify, Stemberger and Stoel-Gammon (1991) suggest phone frequency as the underlying factor of phonological underspecification (1991:193). This can be considered as a different option from the innate underspecification of coronal. Phone frequency as a decisive factor requires knowledge of the entire system and lexicon when deciding on underlying specification. This would reflect the language specific basis proposed in Archangeli (1984). However, as noted before (see 4.2.1), the discussion in Stemberger and Stoel-Gammon (1991) does not include an investigation into the development of the child's lexicon, and the claim that the child throughout the early stages of acquisition has more alveolar segments than labial and/or velar is not an obviously valid one.

The discussion regarding the principles of underspecification offered within the framework of dependency phonology incorporates the language-specific aspect of Archangeli's theory as well (Anderson and Durand 1988a, b). (For a discussion on dependency phonology notation, see III4.). Anderson and Durand (1988b) tentatively propose universal geometrical principles. Illustrated by the vowel system of Yawelmani, they propose the following principle (1988b:2-5):

(12) *System-geometric principle 1*

- a. System geometry:  $\{X\}, \{X,a\}, \{a\}, \{Y\} \rightarrow$  unspecified:  $\{Y\}$   
(where X and Y range over i and u).
- b. Default rule:  $\{ \} \rightarrow Y$ .

The fully specified Yawelmani vowel system (not taking vowel length into consideration) is given in (13a.) besides the fully specified dependency phonology representation of this system (b.).

(13)	a.	i	a	o	u	b.
	high	+	–	–	+	/i/    {i}                    {u}    /u/
	low	–	+	–	–	{a,u}    /o/
	round	–	–	+	+	/a/                    {a}
	back	–	+	+	+	

Applying principle 1 to the specification of this system, as presented in the shaded area, {i} would not receive an underlying characterisation; this segment is unspecified. The identity of the unspecified entity { } is recovered by means of the default rule,  $\{ \} \rightarrow \{i\}$  (13b.)



In the context of the system-geometric principles (in (12) and (17)), the requirement to have "knowledge" of the full system in order to determine the non-specified segment in the inventory ties in with the view that underspecification, as proposed in Archangeli (1984, 1988), is not found in a child's underlying system in a way similar to the underspecification claimed for the adult system, because the child system is different from and more limited than the adult system. The geometrical motivation is discussed in the context of vowels. The extension of this proposal to consonant systems would be of direct interest to the discussion on coronal (consonantal) underspecification here.

Underspecification, in particular the underspecification of the place component coronal, is widely accepted as a characteristic of the adult phonological system on the basis of a variety of phenomena (cf. Paradis and Prunet 1991). From the discussion here it has become clear that similar evidence in favour of underspecification has not been found in the child language data studied here. The assimilation phenomena that are claimed to provide such evidence (Stemberger and Stoel-Gammon 1991, Levelt 1994, Rice and Avery 1995) can be accounted for by means of non-contrastive non-specification. Non-specification is part of the child's phonological development as the absence of contrast does not provide the necessity to specify, and the initial stages of phonological development are characterised by a limited number of phonological contrasts. Non-specification allows free variation, as well as (labial) filling-in, thus giving rise to variability and assimilation, respectively.

The temporal aspect of the assimilation phenomena observed in early child language can be explained by the development of the underlying system. Once all major (place) contrasts are established, all entities are specified, and non-contrastive non-specification is not part of the underlying system anymore. The observation that underspecification in the Archangelian sense is not present in child language and the assumption that it is part of the adult phonological system give rise to the necessity to explain the transition from the one stage to the other, to formulate the motivation for this change and the principles for "specification erasure". Phone frequency (Stemberger and Stoel-Gammon 1991) and system-geometric considerations (Anderson and Durand 1988b) have been proposed in this context. Generally, however, the need to address the question concerning the basis of the coming into existence of underspecification is not acknowledged.

## 6. Glottal stop and [h]

### 6.1 Introduction

Within the ChildPhon corpus of language acquisition data, the overall realisation of vowel-initial target words is remarkable. They are, for the greater majority, realised with a glottal stop initially. This is exemplified by the following forms:

(1)	a.	<i>oma</i>	'grandmother'	/oma/	[ʔo:ma]	2	#5
	b.	<i>aap</i>	'monkey'	/ap/	[ʔap]	2	#3
	c.	<i>eend</i>	'duck'	/ent/	[ʔakt]	7	#11
	d.	<i>uil</i>	'owl'	/œyl/	[ʔuɯw]	7	#16
	e.	<i>ik niet</i>	'not me'	/ɪk 'nit/	[ʔit' 'nit]	4	#8
	f.	<i>olifant</i>	'elephant'	/oli,fant/	[ʔo:ʌɑ̃t]	4	#5

This could be regarded as a straightforward "imitation" by the child of the adult target as it has been shown for Dutch that 'glottal stop is always inserted before a vowel-initial word after a pause' (Booij 1994:65 after Jongenburger and Van Heuven 1991, footnote 13). However, [h] also occurs in this position, albeit to a lesser extent:

(2)	a.	<i>een</i>	'one'	/en/	[he]	8	#12
	b.	<i>aap</i>	'monkey'	/ap/	[ha:p]	2	#2
	c.	<i>Ernie</i>	name	/ɛ.mi/ (/ʌ.mi/)	[hʌnɪ]	4	#5

An "imitation" account can thus only account for part of the data, and is not able to generalise the data sets that appear to represent a coherent group. The insertion of glottal stop and [h] provides an initial segment in the realisation of a vowel-initial target. On the assumption that the child's basic output is based on CV syllables (see also 7.), this insertion can be considered to be simply dictated by his template. This, too, does not seem to cover all relevant data; besides vowel-initial targets, many consonant-initial target words are also realised with either initial glottal stop or [h]. Examples are given in (3). These child language observations render an explanation on basis of just the CV syllable and the need to realise an initial consonant as such not satisfactory either as these target words have themselves initial consonants.

(3)	a.	<i>schaap</i>	'sheep', sing.	/sʰap/	[ʔap]	8	#6
	b.	<i>fles</i>	'bottle'	/flɛs/	[ʔɛis]	9	#5
	c.	<i>televisie</i>	'television'	/telə'visi/	[ʔə 'fisiũ]	2	#14
	d.	<i>klei</i>	'clay'	/klei/	[hæi]	4	#9



In what follows, the distribution of glottal stop and [h] in the ChildPhon acquisition data will be discussed in detail (6.2 and 6.3, respectively), as well as the realisation of vowel-initial target words (6.4). Words that are realised with an initial vowel are subsequently looked at (6.5). The data examples will, in first instance, be taken from Eva (4).

## 6.2 Distribution of glottal stop

The data sets that are discussed in this section characterise the distribution of glottal stop in the output of Eva (4).

(4)	a.	[ʔəʊχə]	<i>vogel</i>	‘bird’	/voχəl/	#3
	b.	[ʔɛ:sɛ]	<i>lezen</i>	‘to read’	/lezə/	#3
	c.	[ʔɪχ]	<i>weg</i>	‘gone’	/vɛχ/	#3
	d.	[ʔɪnə]	<i>vlinder</i>	‘butterfly’	/vlɪndəɪ/	#1
	e.	[ʔɛiθə]	<i>schelpen</i>	‘(sea) shells’	/sχɛlpən/	#3
	f.	[ʔitə]	<i>Marieke</i>	name	/ma'rikə/	#7

As becomes clear from the examples in (4), glottal stop is realised at the place of an initial continuant (4a.-c.) (#1-3). Glottal stop is also realised in the position of an initial target consonant cluster (d.-e.), and the sequence *Mar* in *Marieke* (f.). On the basis of these observations, [ʔ] can be said to function as a dummy consonant for target phonemes or phoneme clusters that are too complex for the child to realise at a particular session.

Glottal stop is also realised in non-initial position. This distribution is exemplified by the forms in (5). The majority of cases in this data set is an instance of glottal reinforcement before [t] (5a.-d.). Glottal stop is also realised before (and after) a fricative (e.-f.), and in the place a final oral or nasal stop (g.-h.).

(5)	a.	[pəʔt]	<i>klok</i>	‘clock’	/klɔk/	#3
	b.	[ʔiʔtʃə]	<i>fietsen</i>	‘to bike’	/fitsən/	#7
	c.	[dɪʔt]	<i>dicht</i>	‘closed’	/dɪχt/	#4
	d.	[boʔtʃ]	<i>boos</i>	‘cross’, adj.	/bos/	#3
	e.	[nøʔs]	<i>neus</i>	‘nose’	/nøs/	#4
	f.	[bo:fʔə ʔo:pə]	<i>boven lopen</i>	‘to walk upstairs’	/bovən ʔopən/	#8
	g.	[sam,baʔ]	<i>ik ook <u>zandbak</u> spelen</i>	‘sandpit’	/zant,bak/	#8
	h.	[pʊrsaʔ]	<i>poezen</i>	‘cats’	/puzən/	#3

Glottal reinforcement of (syllable-final) voiceless plosives in adult language can be explained on a phonetic basis. Before the hold stage of the oral closure (and sometimes during), '[the] vocal folds close tightly together' (Collins and Mees 1984:135), resulting in a glottal stop reinforcing the oral articulation (discussed with reference to English). The occurrences of [ʔ] before [t] can be accounted for on these grounds. However, on the whole, the instances of glottal reinforcement here appear less systematic, and a consequence of the child's not yet fully developed command of the gestures. In all the child forms in (5), the glottal stop either fills a target consonant slot or appears to reinforce the consonantal status of the phoneme it accompanies. Here again, glottal stop seems to function as a marker of consonantality, structurally and/or phonetically.

The third group of child realisations represents the occurrence of glottal stop in initial position in the place of target /h/. In these examples, presented in (6), glottal stop alternates with [h] in the child's realisations, amongst others (see 6.3).<sup>1</sup>

(6)	a.	[ʔan]	<i>haan</i>	'cock'	/han/	#3
	b.	[ʔɑːmʉnə]	<i>handschoenen</i>	'gloves'	/hant,sχunə/	#3

### 6.3 Distribution of [h]

[h] occurs predominantly in initial position, and there it reflects a similar distribution as for glottal stop (not taking the /h/-initial target words into account).<sup>2</sup> Namely, [h] is realised in the place of an initial consonant cluster (7a.-d.), an initial continuant (f.-h.) and of the *Mar* sequence in *Marieke* (i.).

(7)	a.	[hæi]	<i>klei</i>	'clay'	/klei/	#9
	b.	[hɪχə]	<i>vlinder</i>	'butterfly'	/vlɪndəɪ/	#3
	c.	[høtœyʉw]	<i>sleutel</i>	'key'	/sløtəl/	#1
	d.	[fiɔːmɪəː]	<i>schommel</i>	'swing'	/sχɔməl/	#4
	e.	[ɦeɪtəː]	<i>geitje</i>	'goat', dim.	/ɦeɪtjə/	#4
	f.	[ɦɪtʰ]	<i>fiets</i>	'bicycle'	/ɦɪts/	#2
	g.	[ɦuʉf]	<i>woef</i>	'woof!'	/vʉʉf/	#1
	h.	[ɦiaʔtʂə]	<i>laarzen</i>	'boots'	/laɪzə/	#5
	i.	[ɦitə]	<i>Marieke spelen</i>	name	/ma'rikə/	#7

<sup>1</sup> A similar alternation [ʔ ~ h] is reported in the phone trees of the children studied in Ferguson and Farwell (1975:426-27). (For a brief discussion of this article, see I4.2.3.1.)

<sup>2</sup> Throughout the discussion, [h] will be used to refer to both [h] and [ɦ].

[h] appears to fulfil a similar function as glottal stop. It is a dummy consonant occurring rather than, for instance, a cluster that is too difficult, or a categorially complex target such as a continuant. In relation to the continuants, another aspect becomes clear. In many words, [h] alternates with glottal stop and/or with another, apparently “filled-in”, phoneme. This is illustrated by the child forms in (8a.-c.). For the continuants, this pattern is observed during #1-5. For the initial consonant clusters a similar alternation occurs, though less frequently (8d.-f.). It can thus be concluded that a cluster or continuant is realised as a glottal stop, [h] or by means of a phoneme the characterisation of which is obtained through filling-in from a surrounding phoneme(s) (see also 7.2.2).

(8)	a.	<i>vis</i>	‘fish’	/vis/	[his	ʔis	ʔis	ʔdis]	#3
	b.	<i>weg</i>	‘gone’	/vex/	[firχ	ʔiχ	ʔæχ	ʔeχ]	#3
	c.	<i>voeten</i>	‘feet’	/vutən/	[hutæ	ʔutɛ]			#3
	d.	<i>fles</i>	‘bottle’	/fles/	[hes	ʔeχs	ʔes]		#3
	e.	<i>vliegen</i>	‘to fly’	/vliχə/	[hiχ	ʔiχä]			#3
	f.	<i>prik</i>	‘prick, injection’	/prik/	[hit	ʔit	ʔit]		#1

This pattern, alternation of [h ʔ] and filling-in, is also observed in a third, minority group that is constituted by a few forms. They can be described as target words with a single oral stop in initial position that is realised as an initial dummy consonant, amongst other things. The alternative realisations occur in the context of a multi-session time span as becomes clear in (9).

(9)	a.	<i>tandenpoetsen</i>	‘to brush one’s teeth’	i	[pʊanə ʔutʂə	ʔanə ʔutʂə]	#4
			/tandənputsən/	ii	[ʔanəputʂhe]		#5
				iii	[ʔanʔut]		#6
	b.	<i>koffie</i>	‘coffee’	i	[pɔf]		#3
			/kɔfi/	ii	[ʔiɔfi]		#4
				iii	[pɔfi]		#5

Residue forms are *eendje* ‘duck’, dim. /entjə/ and *betalen* ‘to pay’ /bətələn/, [ʔenthə] #6 and [ta:t,hə] #3 respectively, where [h] does not occur in initial position. The forms in this third group do not seem to constitute a coherent, representative group.

#### 6.4 Realisation of vowel-initial words

The initial observation in 6.1 concerns target words with an initial vowel that do not have a vowel-initial realisation. Characteristically, their realisation has a glottal stop or [h] in word-initial position (6.2-3). Here, the realisations of vowel-initial words is discussed in as far as they are not covered by this default group, i.e. initial glottal stop and [h]. Some vowel-initial realisations occur in the data of Eva (4). For a discussion of these forms see 6.5.

The child forms in (10) represent the realisations of vowel-initial target words that do not have [h ?] or a vowel in initial position.

(10)	a.	[pu'seɪj]	<i>poes aaïen</i>	'to stroke cat'	/pus 'aijən/	#8
	b.	[tɔm'ɪʃ]	<i>Loetje kom eens</i>	'come then'	/kɔm 'ens/	#8
	c.	[mɛi'jɔtɔ:]	<i>mij auto</i>	'me car'	/mɛi 'ɔtɔ/	#7
	d.	[di.jɔpəmatə]	<i>die openmaken</i>	'to open that one'	/di 'ɔpəmakə/	#6
	e.	[pɔ: 'tɔpɛ]	<i>poort open</i>	'gate open'	/pɔɪt 'ɔpə/	#7
	f.	[nɔχe:n]	<i>nog een</i>	'another one'	/nɔχ ,en/	#6
	g.	[jɛi 'jɔ:]	<i>jij ook niet</i>	'not you either'	/jɛi 'ok/	#10
	h.	[di 'jɔ: 'kaiə]	<i>die ook aaïen</i>	'to stroke that one too'	/di 'ok 'aijən/	#10

Different categories can be established on the basis of these realisations, namely:

- i. concatenation<sup>3</sup> with preceding word; the final consonant of the preceding word provides the syllable-initial consonant (10a.- b.).
- ii. concatenation with preceding word that ends in a vowel; an intermediate consonantal syllable slot is provided with an articulatory specification through filling-in (10c.-d.).

Parallel to i. and ii. are two categories that display the same mechanism, without concatenation of the two words, the second of which has a vowel in initial target position:

- iii. the final consonant of the preceding word is not realised word finally; instead it becomes the word-initial consonant in the originally vowel-initial target word (10e.-f.).
- iv. in the case of a vowel-final preceding word, a word-initial consonant slot, that is assumed to be underlyingly present on basis of the CV syllable template, is filled with the articulatory specification of the preceding word-final vowel (10g.-h.).

<sup>3</sup> Here and elsewhere, *concatenation* refers to the elimination of a pause between two separate and adjacent parts in an utterance, so that they are connected in (the child's) speech.

Note, in this context, that /h/-initial target words are also realised according to the categories described above, namely (11a.-b.) are instances of the iii. and iv. categories, respectively. (11c.-e.) illustrate filling-in from surrounding segments.

(11)	a.	[niˈtɛ:t]	<i>niet heet</i>	‘not hot’	/not ˈfiet/	#10
	b.	[jei ʃɛp]	<i>jij hebt koude voeten</i>	‘you have’	/jei ˈhept/	#10
	c.	[nat ˈtɑːɪ]	<i>nat haar</i>	‘wet hair’	/nat ˈhaɪ/	#7
	d.	[dosʃɛbə]	<i>doos hebben</i>	‘to have box’	/dos ˈhɛbən/	#7
	e.	[tæit]	<i>heet</i>	‘hot’	/fiet/	#1

Besides the default realisation with dummy consonants [ʔ h], vowel-initial target words are realised with an initial consonant, namely by means of filling-in through spreading from (a) surrounding segment(s), or through “annexation” from the preceding word-final consonant. In either case, concatenation is optional. In 6.3, the alternation [ʔ h] and filling-in has already been observed in relation to target words with complex initial segments or segment sequences. /h/-initial target words behave like vowel-initial words with regard to the filling-in of articulatory specification.

### 6.5 Vowel-initial realisations

The words that are realised with a vowel in initial position can be categorised in two main groups and a residual group. Examples from the first group are presented in (12).

				A	B
(12)					
a.	<i>auto</i>	‘car’	/oto/	#1 [ʔutjau]	#3 [ʔotqũ]
				#2 [ˈatav nˈtoũ ˌɛˈtoũ]	
b.	<i>eend</i>	‘duck’	/ent/	#2 [ˈɛin ˈɛɪn]	#3 [ʔɛn ʔɛːn]
c.	<i>open</i>	‘open’	/opə/	#1 [ˈopə ˈopə]	#4 [ʔoũpəː]
				#2 [ˈoũpə ˈoũbä ˈoũpəː]	
d.	<i>oog</i>	‘eye’	/oχ/	#1 [ʔox]	#3 [ʔoχ]

Vowel-initial target words are realised with a vowel in initial position in #1 and/or #2. These forms constitute the first occurrences of these target words (A). The subsequent realisation of these words is not vowel-initial, and mostly has a glottal stop in initial position (B).<sup>4</sup> So, after the

<sup>4</sup> Apparently, [ʔ] is ignored in cases like this in Vihman, Ferguson and Elbert (1986:11): ‘Where no consonant appeared in the child’s word, it was listed as vowel initial (e.g., [ʔə] (*h*)air ...).’ (For a brief discussion of this article, see I4.2.3.2.)

initial, anomalous realisation, from the point of view of the assumption that the child's early words are realised according to a CV template, the words in this group are produced with an initial consonantal phoneme. The vowel-initial realisations can thus be regarded not as exceptions, but merely as pre-systematic forms that are quickly adapted to conform to the standard template.

The second group consists of individual words that occur regularly, namely *ook* 'also' and *Marieke*. *Ook* occurs in many different phrases, and appears to be a word that is recognised early as a vowel-initial word, although glottal realisations occur as well (13a.-b.). *Marieke* presents a different picture, namely one of great variability (c.-e.). The sequence *Mar* appears to present the child with a difficult target judging from the variable forms throughout #1-10. Here too the alternation between glottal stop, [h] and a phoneme resulting from a filling-in operation in the initial consonantal slot can be regarded as an attempt to satisfy the CV template, on the one hand, and, on the other, an effort to realise a difficult sequence, comparable with an initial consonant cluster. *Marieke* can only be concluded to be unstable up to and including #10.

(13)	a.	[di'ok 'nit]	<i>die ook niet</i>	'neither that one'	/di'ok 'nit/	#7
	b.	[vɛi'otə 'laɪzə]	<i>wij ook laarzen</i>	'we too boots'	/vɛi'ok 'laɪzə/	#9
	c.	[hitə 'hitə 'ʔitə: 'jitə: 'ʔitə]	<i>Marieke</i>	name	/ma'rikə/	#2-8
	d.	[itə 'ʔot 'ʔi' to:k 'ʔikə 'ʔo:k]	<i>Marieke ook</i>	'Marieke also'	/ma'rikə 'ok/	#5-10
	e.	[ʔikə 'na' i' tu]	<i>ik naar Marieke toe</i>	'I to Marieke'	/ik 'nar ma'rikə 'tu/	#10

A residual group can be observed that, again, seems to comprise exceptional forms that do not appear to be a representative sample of the data. The sub-groups are exemplified in (14) and described below:

(14)	a.	[ʔopəma'tə]	<i>openmaken</i>	'to open'	/opəmakən /	#7
	b.	[ʔit 'o:pəma'tə:]	<i>ik openmaken</i>	'I open'	/ik 'opəmakən/	#7
	c.	[di 'ɔɪt 'nit'taɪ]	<i>die hoort niet daar</i>	'that one does not belong there'	/di 'hɔɪt 'nit 'daɪr/	#7
	d.	[di 'hɔɪt 'fiɪɪ]	<i>die hoort hier</i>	'that one belongs here'	/di 'hɔɪt 'hiɪr/	#7
	e.	[di 'ɛp]	<i>die heb (ik)</i>	'(I) have that one'	/di 'hɛp/	#4
	f.	[da 'ɔ:p]	<i>daar op</i>	'on there'	/daɪɔp/	#5
	g.	[hɛ 'ɪsə 'taŋ le:tə/sə:]	<i>hij is krant (aan het) lezen</i>	'he is read(ing) newspaper'	/hɛi 'ɪs 'krant 'lezən/	#4



1. vowel-initial words are realised both with a vowel in initial position, as well as with a glottal stop initially (14a.-b.).
2. words with an /h/ in initial position are realised with a vowel in initial position, as well as with [h] initially; /h/ is not always realised (14c.-e.).
3. vowel-initial words are realised as vowel-initial words (14f.-g.).

Leaving aside *ook*, *Marieke* and the small residual group of alternating realisations, the vowel-initial realisations, rather than constituting an exception to the CV syllable template underlying the child's production, illustrate just this. These forms only occur as early forms and first occurrences, and the CV implementation is completed swiftly.

#### 6.6 Other children

In the data of the other children (Robin 2, Tom 7, Jarmo 8 and Elke 9) similar categories can be observed. The main difference with the data from Eva (4), discussed above, is in the extent to which the various phenomena, i.e. dummy [ʔ h], non-vowel-initial realisation of vowel-initial words, etc., occur.

The output of Tom (7) and Elke (9) proves more systematic in that the occurrence of residual forms is minimal, and vowel-initial words are consistently produced with a consonantal realisation in the initial slot. Jarmo (8) does not have vowel-initial realisations either. Note that Tom attempts many vowel-initial target words.

Robin (2) applies the dummy consonant strategy more extensively than Eva (4) in the context of liquids, and has an [h] realisation for initial liquids. He also has a more varied syllable structure realisation. Vowel initial words are mainly realised as vowel-initial realisations during #22-#24, and with variable realisations from #19 on. Pre-systematic forms make up a small part of Robin's vowel-initial realisations during the earlier recording sessions. With regard to the function of glottal stop, this is also realised in final position in Robin's output in the place of a consonant or consonant cluster (15a.-b.). Apparently, Robin has established a CVC syllable underlyingly, as some CV target words are also realised with a glottal stop in final position (c.-d.). Here too, [ʔ] represents consonantality, albeit in post-vocalic position.

(15)	a.	[diʔaʼ]	<i>tiktak</i>	'ticktock'	/tɪktak/	#4
	b.	[baʔseijə]	<i>gaan volgende <u>bladzijde</u></i>	'page'	/blatzeidə/	#22
	c.	[baʔ]	<i>bah</i>	'poo!'	/ba/	#1
	d.	[ʒaʔ]	<i>zo</i>	'so'	/zo:/	#5

Note that the child's "use" of [ʔ h] appears to be different from the realisation of other segments in the child's output that are different from the target segments; [ʔ h] do not necessarily occur in a period of variability or instability. The main motivation for their occurrence appears to be satisfaction of the CV syllable template and an articulatorily easy alternative to oral segments.

In comparison to the other children, Eva (4) can be regarded as having a relatively rigid CV protostructure. For a discussion of this observation, see 7..

### 6.7 Conclusion

On basis of the observation regarding the distribution of glottal stop and [h], the realisation of vowel-initial words, and vowel-initial realisations, it can be concluded that:

- i. [ʔ h] occur in the place of initial consonant clusters, functioning as dummy consonant for a complex structure.
- ii. [ʔ h] occur in the place of initial continuants, functioning as alternatives, possibly beside a "filled-in" phoneme, for categorically complex segments.
- iii. [ʔ] also occurs as glottal replacement or reinforcement of plosives.
- iv. besides realisations with [ʔ h] initially, vowel-initial words are realised with an "annexed" initial consonant, taken from the preceding, consonant-final word, or, in the case of a vowel-final preceding word, the consonant slot in the CV syllable template receives its articulatory specification through filling-in. The new syllable-initial consonant optionally occurs in word-initial position, as an alternative to concatenation.
- v. /h/-initial target words behave like vowel-initial target words with regard to the filling-in of articulatory specification.
- vi. vowel-initial realisation of vowel-initial words appear to be pre-systematic forms that are realised with a dummy consonant in subsequent sessions.

These conclusions reflect two things, amongst others. The CV template is a dominant characteristic of the child's realisations during the early stages of acquisition. Where the target

word does not satisfy this structure in the sense that it lacks an initial consonant, the structure will be “adapted”, and an initial consonant realised in the form of a glottal stop or [h] as dummy consonants. In the case that the target word has an initial consonant or consonant cluster that the child is not yet able to realise consistently, a dummy consonant can fill the initial slot as well. (For a detailed discussion of the CV pattern and the mechanism of filling-in articulatory specification, see 7.)

The CV syllable is also associated with matters of optimality.

Optimality Theory [OT] proposes that Universal Grammar contains a set of violable constraints. The constraints ... spell out universal properties of language. OT also proposes that each language has its own ranking for these constraints. Differences between constraint rankings result in different patterns, giving rise to systematic variation between languages (Archangeli 1997:11).

With regard to syllable structure in particular, the general tendencies of syllables can be formulated on basis of the possible syllables. For instance, “syllables begin with a consonant”. The tendencies formulated in Archangeli (1997:7) are listed below:

- |      |  |              |
|------|--|--------------|
| (16) | <i>Typical properties of syllables</i>           |              |
| a.   | Syllables begin with a consonant.                | ONSET        |
| b.   | Syllables have one vowel.                        | PEAK         |
| c.   | Syllables end with a vowel.                      | NO CODA      |
| d.   | Syllables have at most one consonant at an edge. | *COMPLEX     |
| e.   | Syllables are composed of consonants and vowels. | ONSET & PEAK |

These are subsequently regarded as a constraint in optimality theory, e.g. ONSET (1997:12). Constraints are ranked, and the ranking for the syllable constraints here is given (from the highest to the lowest ranked): PEAK, ONSET, \*COMPLEX, ... NO CODA. ‘The optimal [syllable] is the one with the fewest lowest violations’ (1997:12). The CV syllable does not violate any of the constraints listed in (16), and can thus be concluded to be the preferred syllable in optimality terms. Indeed, the high ranking of the ONSET constraint is reflected in the realisations of the children studied during the early development of their phonological system. The child’s initial template, as becomes clear from his utterances, is also unmarked in terms of optimality theory because no constraints are violated (1997:25). So, CV can be considered the most basic and universal syllable, which is innate. The child will violate the syllable constraints on basis of language particular evidence, or experience (Smolensky 1997).

Secondly, it has been argued elsewhere that glottal stop and [h] can be regarded as segments that are characterised by the absence of a supralaryngeal specification. As non-oral segments, they are not specified articulatory.

... the glottal stop is frequently a realisation of the neutralisation of a contrast amongst the voiceless stops, i.e. ... it bears the same sort of relationship to voiceless stops as the reduced vowel does to full vowels (Anderson and Ewen 1987:190).

In relation to the acquisition data discussed here, this description makes sense.<sup>5</sup> The glottal stop occurs in the initial position of various categories of child target words (words that have either a vowel, a continuant or a consonant cluster in initial position) for the sake of its consonantal status only, in order to satisfy the CV template. It is only categorial information, and not articulatory information that is relevant here.<sup>6</sup>

Assuming that /h/ is not specified articulatory, the similar pattern of filling-in articulatory specification of a word-initial consonant slot for a vowel-initial word plus "template" consonant slot and a /h/-initial word can be explained. In neither case, the initial consonant slot has a articulatory specification, and receives this by spreading the specification of surrounding segments to this slot.

Given the numerous occurrences of glottal stop, on the one hand, and the status of /h/ as glottal fricative, the child's initial non-contrastiveness between stop and fricative, and its less frequent occurrence as dummy consonant in relation to glottal stop, on the other, [h] in this context is assumed to be a variant of glottal stop. In line with the "proto-consonant status" of glottal stop as stated above, glottal stop is assumed here to be the default dummy consonant.

<sup>5</sup> The alternation [ʔ h] and stop (e.g. [p t k]) in initial position points to a representation in which the articulatory gesture in the initial consonant slot is actually present, and empty for [ʔ h]. It has been argued in Anderson (1994:11) and Anderson and Durand (1988a) that /h/ and glottal stop are characterised by the absence rather than the non-specification of the articulatory gesture. This would imply that the child learns not to represent an articulatory gesture for these two segments, at a later stage than represented by the data studied here. For instance, the loss of the gesture could come about by means of representation redescription (see I4.3).

<sup>6</sup> A similar phenomenon is reported for syllable final position in Rice and Avery (1995:37). Glottal stop is realised when underlyingly the consonantal slot is present and there is no segmental specification to fill the slot yet: 'Tessa is developing the necessary structure for the realization of a final consonant [in order to say *boat*]. When the position is there, it is initially realized as a glottal stop'. Also, cf. Stemberger (1993).

From a phonetic, rather than a representational perspective, the choice of glottal stop as default dummy consonant can be explained by the actual articulation, namely the characteristic sealing off of the vocal tract, i.e. glottal stricture (Lass 1976:148, footnote 1). As a consequence of this stricture 'a percussive effect ... analogous to that of (k) or any other "stopped" consonant' occurs (1976:146 after Sweet 1877). This ties in with the function of [ʔ] in the child's early realisations, namely as a marker of consonantality (see 6.2). The glottal stop '[cuts] off sharply the voicing of the preceding vowel' in the case of pre-glottalisation (Collins and Mees 1984:135). In Dutch, the insertion of [ʔ] occurs before a vowel-initial word after a pause, and word-internally, in foot-initial position (Booij 1997:65, footnote 13). This is similar to the distribution of glottal stop in German (see below). With regard to the phonological functions of [ʔ], Lass (1976:149, footnote 3) notes the following:

... the use of [ʔ] as a marker of syllable onset ... may very well be segmental phonological in a very simple way. Thus dialects with obligatory [ʔ] before initial vowels may have a phonotactic structure that forbids /#V-/, but allows only /#CV-/ as a minimum initial cluster. In this case [ʔ] is a realization of /C/ (unspecified further), which contrasts with all other consonants. ... As a further possible support, note that in Old Germanic poetry, while consonants alliterate only with each other, ALL vowel-initials form an alliterating class. This may suggest that they are phonologically all /#CV-/, i.e. that there is no syllable type \*/#V-/.

Kohler (1994) investigates glottal stops and glottalisation as boundary markers in German (colloquial read speech of a North German non-dialect variety), by means of auditory and instrumental analysis. '[I]n the phonology of German ... the glottal stop is a potential sound feature before the initial vowels of words and stem morphemes, e.g. [ʔ]er[ʔ]arbeiten, ver[ʔ]eisen, also before the initial vowels of prefixes, as in [ʔ]Auf[ʔ]erstehung, wieder[ʔ]er[ʔ]obern, and of words in compounds, as in *Glatt[ʔ]eis* ...' (1994:38) ('to achieve through work or study, to win, to conquer', 'to become ice, to become covered with ice', 'resurrection', 'to conquer, win or take again' and 'glazed frost', respectively). His findings are that 'voiceless plosives enhance the occurrence of glottal stop at word boundaries because the glottal closure serves as a means to cutting off the air stream' (1994:45). In the context of *vorhanden* and the glottalised realisation /nn̥n/, the following is noted:

What happens here is clearly the transfer of a constrictive valve action on the air stream from the velum to the glottis. The function of the two different articulatory gestures remains identical, namely to produce a sudden substantial lowering of air flow in order to signal a stop consonant interruption to a hearer. By moving this regulative action from the upper to the lower valve, no separate gestures are necessary at the velum nor at the tongue tip, and the same function can thus be achieved with fewer, simplified gestures

and therefore with less articulatory effort, which is the essence of reduction in connected speech (1994:50).

So, glottal stop can be regarded as marker of consonantality as it indicates a stop articulation by lowering or cutting off the air flow, and thus it clearly signals the distinction vowel v. consonant. Secondly, it is articulatorily easier than an oral articulation. This ease of articulation of [ʔ] over an orally articulated stop and its ability to signal the consonant v. vowel distinction clarifies the occurrence of glottal stop in the child data studied

Note that the systematic use of [ʔ] as dummy consonant, as observed in the ChildPhon data, renders an account of place of articulation development and/or harmony in phonological acquisition in terms of coronal underspecification highly unlikely. Articulatorily non-specified initial consonants (slots) are not realised as alveolar (see 4.).



... accepting limitations ... but these borders  
do not necessarily represent a negative reality.  
They often stimulate our creativity to find freedom  
and fantasy within the space we are assigned.

Kylián, choreographer *Symphony of Psalms*  
Edinburgh International Festival 1996

## 7. CV protostructure I: practice space

### 7.1 Introduction

During the early stages of language acquisition, the CV unit is the basic structural unit in the child's output. The sequence of consonant + vowel is generally acknowledged to be the starting point for the child's categorial development (Fikkert 1994, Levelt 1994, Iverson and Wheeler 1987, Berman 1977, Waterson 1971b, Jakobson 1968). Amongst the CV units in the child's production, the sequence oral stop + vowel is the most predominant in early acquisitional output (see 7.3).

In the data of the five Dutch children studied, there is strong support for the role of CV as basic unit. As has already been seen in the discussion on the occurrence of glottal stop and [h] in early language data, the child's output overall satisfies the CV structure (see 6.7.).<sup>1</sup> The emphasis in 6. was on the role of [ʔ h]. These segments were concluded to function as default consonants. The occurrence of these dummy consonants is closely related to the CV structure. For instance, the realisation of vowel initial words has in the great majority of cases a glottal stop or [h] in initial position (6.4). In this respect, this section and the discussion on default consonants overlap to a certain extent.<sup>2</sup>

The focus here is on the different strategies of the child to realise an adult target so as to satisfy the structural requirements of his output.<sup>3</sup> The role of this basic structure will be discussed (7.4). The identity in terms of categorial and articulatory realisation of the CV structure will be briefly addressed as well (7.3).

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<sup>1</sup> *CV structure* will be used here to refer to a sequence of n CV units in a child's utterance. These units do not necessarily occur within the scope of one word in an utterance.

<sup>2</sup> For examples from Eva (4) illustrating the different strategies discussed here, see II6..

<sup>3</sup> Cf. Fikkert (1994; chapter 4) *The acquisition of syllable structure: the onset*.

This section is not intended as a comprehensive overview of cluster realisation or breaking, nor of syllable structure development. The aim of the discussion here is to provide an impression, on basis of examples from the acquisitional data, of the ways in which the child maintains his basic CV structure when target words deviate from this. As becomes clear from the examples, it is possible that a child presents realisations that illustrate a particular strategy, while at the same time realising the target word in an alternative way.

## 7.2 Strategies

The two main target structures that do not satisfy the child's basic output form, based on CV units, are words that have either a vowel or a consonant cluster in initial position. They are realised in an "adapted" form determined by the child's perception and production abilities. The strategies that the child adopts, as they become evident from the Dutch acquisition data, are discussed below (7.2.1-4).

With regard to the consonant(s) in syllable-final position, these are not considered here. The basic unit that characterises the child's output in the early stages of acquisition does not include such a position. The syllable template of some children includes a syllable-final position at some point in their development during the observation period. In that case, consonants are realised in that slot, e.g. boot 'boat' /bot/ 2 #7 [pʊt] CVC. Mostly, however, the syllable-final consonant(s) of the target word is not realised. They are simply left out of consideration as the child cannot take them into account because of his early syllable template. This template is constituted by the syllable structure that is mastered by the child on a cognitive level as evidenced in his output.

### 7.2.1 *Dummy consonants*

The occurrence of [ʔ h] as dummy consonants is discussed in detail in 6., Glottal stop and [h]. In the case of a vowel-initial target word, the child will realise the (articulatory) non-specified segment as a glottal stop or [h], instead of a vowel-initial realisation. A dummy consonant also occurs in the place of a structure in initial position that is too complex for the child at that particular time, such as a consonant cluster. In both cases, the target structure (e.g. VCV, CCVCV) that does not conform to the child's basic syllable structure is realised by the child in terms of CV units. Examples are presented in (1) (a.-h. consonant clusters, i.-q. vowel initial target words).

(1)	a.	[ʔap]	<i>schaap</i>	'sheep', sing.	/sʰap/	#13	8
	b.	[ʔa:jə]	<i>draaien</i>	'to turn'	/drajən/	#2	8
	c.	[ʔotoʔant ʔo:to]	<i>grote brand-weerauto</i>	'big fire-engine'	/χrotə 'brant,ve:ʔo:to/	#12	2
	d.	[ʰomow]	<i>schommel</i>	'swing'	/sʰoməl/	#20	8
	e.	[ʰuməcə]	<i>bloemetje</i>	'flower', dim.	/blumətjə/	#21	8
	f.	[ʰuʃ, iʃ, ]	<i>schoentjes</i>	'shoes', dim.	/sʰuntjəs/	#5	9
	g.	[ʰoi:tita]	<i>schoot zitten</i>	'to sit on lap'	/sʰot 'zitən/	#18	7
	h.	[ʰiantəfɪɹ]	<i>brandweer</i>	'fire brigade'	/brant,veɹ/	#13	2
	i.	[ʔa:p]	<i>aap</i>	'monkey'	/ap/	#5	2
	j.	[ʔæytə 'duʃʷ]	<i>uit de douche</i>	'out of the shower'	/æyt də 'duʃ/	#21	2
	k.	[ʔetat]	<i>is dat</i>	'is that'	/ɹs 'dat/	#25	7
	l.	[ʔa,beijə]	<i>aardbeien</i>	'strawberries'	/aɹd,beijən/	#15	9
	m.	[ʔok 'tɪt]	<i>ook fiets</i>	'also bicycle'	/ok 'fɪts/	#12	9
	n.	[ʰai,ʃetə]	<i>uitzetten</i>	'to turn off'	/æyt,zetən/	#17	7
	o.	[ʰɹ 'tat]	<i>is dat</i>	'is that'	/ɹs 'dat/	#13	7
	p.	[ʰei]	<i>ei</i>	'egg'	/ei/	#12	8
	q.	[ʰeje 'tuəjə]	<i>even draaien</i>	'just turn'	/evən 'draijən/	#23	8

The extent to which this phenomenon is observed in the data of individual children varies.

### 7.2.2 Filling-in

A target word with a consonant cluster of a vowel initially can be realised by means of a dummy consonant in the initial C slot of the child's template, as discussed above (7.2.1). Another strategy to deal with such targets is filling-in, i.e. the initial consonant slot receives its articulatory specification through spreading of the specification from other segment(s) in the child's form. The filling-in mechanism referred to here is similar to that of labial filling-in of alveolar or velar segments that are still (non-contrastively) unspecified (see 5.4.1); it involves an unspecified segment slot that receives a specification through the spreading of segmental information.

In the case of target words with a cluster in initial position, this sequence of consonants is not implemented in the child's interpretation of the word. Rather, an articulatory empty slot is present underlyingly according to the child's basic template. This slot is optionally filled-in by receiving the articulatory specification of a surrounding segment(s). Examples are given in (2).

(2)	a.	[pʌm]	<i>schoen</i>	'shoe'	/sʰun/	#5	2
	b.	[ʔm 'pa:p]	<i>trap</i>	'staircase'	/trəp/	#11	2
	c.	[ʔa: 'pa:p'ɹ]	<i>daar slapen</i>	'to sleep there'	/daɹ 'slapən/	#8	2
	d.	[jix'ä]	<i>vliegen</i>	'to fly'	/vliχə/	#3	4

e.	[pɔfə:]	<i>sloffen</i>	'slippers'	/slɔfə/	#5	4
f.	[panəpukə 'kɛk]	<i>pannekoeken spek</i>	'pancakes with bacon'	/panəkukən 'spek/	#23	7
g.	[pumə]	<i>schoenen</i>	'shoes'	/sχunə/	#7	9

Initial target clusters that are realised through filling-in (examples in (2)) are also encountered in the child's output as a dummy consonant, or a partial realisation of the cluster, as illustrated in (3a.-b.).

(3)	a.	[hiχ]	<i>vliegen</i>	'to fly'	/vliχə/	#3	4
	b.	[sunə]	<i>schoenen</i>	'shoe'	/sχunə/	#14	9

With regard to vowel-initial target words, they are realised with a consonant initially. The child's realisations thus conform to the basic CV structure. The initial pre-vocal consonant slot that is present underlyingly on basis of the CV template is empty, and subsequently filled-in as it receives articulatory information from a surrounding segment(s).

(4)	a.	[bapys <sup>w</sup> 'e:tə]	<i>appelmoes eten</i>	'to eat apple sauce'	/apəl,mus 'etən/	#19	2
	b.	[wapj]	<i>aapje</i>	'monkey', dim.	/apjə/	#11	7
	c.	[tita? di'tjat də 'tat 'didap]	<i>is dat</i>	'is that'	/ɪs 'dat/	#19	7
	d.	[dɔtə 'χlant 'falä]	<i>op de grond gevallen</i>	'fallen on the ground'	/ɔp də 'χrɔnt χə'valən/	#20	7
	e.	[neni]	<i>Ernie</i>	name	/ɛ.mi/ (/ʌ.mi/)	#11	8
	f.	[tata 'tita 'bipa]	<i>auto</i>	'car'	/oto/	#7	8
	g.	[papu]	<i>appel</i>	'apple'	/apəl/	#5	9
	h.	[tœyt]	<i>uit</i>	'out'	/œyt/	#17	9
	i.	[pə'tutʊ]	<i>een auto</i>	'a car'	/ən 'oʊto/	#4	9

For vowel-initial targets too, the filling-in mechanism is used alongside another strategy, namely realisation through dummy consonants (see below). This optionality for vowel-initial target words supports the analysis of the child realisations of consonant clusters as underlyingly empty slots that are filled-in. The examples in (5) illustrate the alternative dummy consonant realisations.<sup>4</sup> (For *is dat* 7 #19 and #25, see 7.2.1.)

<sup>4</sup> Eva (4) does not generally use the filling-in strategy, and primarily applies the dummy consonant strategy. Her forms are studied in detail in II6., and are not taken into account with regard to filled-in initial consonant realisations discussed here.

(5)	a.	[ʔapɔsʰe:tə ʔapɔsʰe:tə]	<i>appelmoes eten</i>	‘to eat apple sauce’	/apəl,mus ‘etən/	#9,10	2
	b.	[ʔʉni ʰuni hāni ʔĕni]	<i>Ernie</i>	name	/ɛ.ni/ (/ʌ.ni/)	#11	8
	c.	[ʔotō ʔatō]	<i>auto</i>	‘car’	/oto/	#7	8
	d.	[ʔafo ʔapɔ]	<i>appel</i>	‘appel’	/apəl/	#5	9
	e.	[ʔayt ʔæytʃ]	<i>uit</i>	‘out’	/æyt/	#17	9

### 7.2.3 CVCV across words

In the ChildPhon acquisition data, vowel-initial target words are mostly realised in such a way that the vowel slot is not in initial position of the word. Attested strategies to achieve this is to insert a dummy consonant in initial position (7.2.1), or to acquire an articulatory specification for the empty word-initial C slot in the CV basic unit through filling-in from a segment(s) in the word (7.2.2). Another strategy for this group of target words is to attain a CV realisation by incorporating the preceding word and/or syllable in the scope of the realisation. Within the resulting domain either the word-final consonant is annexed to be realised as word-initial consonant, thus succeeding in attaining a complete CV sequence, or the initial consonantal slot receives its articulatory (and possibly its categorial) specification through filling-in from a segment in the previous word. In either case, concatenation is possible, i.e. the vowel-initial target and the preceding target word are realised as one. The different options of this strategy, to attain CVCV *across words*, that are observed in Eva’s (4) data (discussed in 6.4) are repeated in (6).

- (6)
- i. concatenation with preceding word-final consonant.
  - ii. concatenation with preceding word-final vowel, consonant slot filled.
  - iii. word-final consonant from preceding word is realised as word-initial of vowel-initial word.
  - iv. the word-initial consonantal slot is filled with articulatory information from preceding word-final vowel.

These options are also illustrated in the data from the four other Dutch children (I-IV in (7), respectively). Note that in *een appeltje* 2 #22, *appeltje* is realised as a concatenated utterance with a syllable-initial consonant through filling-in (FI) from the preceding consonant, rather than annexation (7Id.).

(7)	I	a.	[dɪsə ʰœys]	<i>dit een huis</i>	‘this a house’	/dɪt ən ʰœys/	#23	8
		b.	[tətə ʰmoût]	<i>dat een boot</i>	‘that a boat’	/dət ən ʰbot/	#21	7

	c.	[mɑ'χeɪfə 'ʔœyt]	<i>mag even uit</i>	'is allowed out for a while'	/mɑχ 'evən 'ʔœyt/	#25	7
(FI)	d.	[e:n'napəɪjə]	<i>een appeltje</i>	'an apple', dim.	/ən 'apəlɪjə/	#22	2
II	e.	[nauvɛi]	<i>mama nou een eendje</i>	'mamma now a little duck'	/nau ən/ #25	7	
III	f.	[χa' 'te:fə 'fiæijə]	<i>gaat even rijden</i>	'goes riding/driving for a while'	/χat 'evən 'reɪdə/ (/reɪijə/)	#21	2
	g.	[ʔoʊtos'ʒur 'kɪk]	<i>auto's zoek ik</i>	'I look for cars'	/otos 'zʊk 'ɪk/	#22	2
	h.	[mo:nɪn 'tafəɪɒpə]	<i>mag niet afgelopen doen</i>	'is not allowed/ should not do (be) finished'	/mɑχ 'nit 'afχəɪɒpən/	#25	7
IV	i.	[sʊpi jə 'hɔ:k]	<i>Snoopy op hok</i>	'Snoopy on kennel'	/snʊpi ɔp 'hɔk/	#21	7

II and IV are in partially similar to the filling-in strategy (7.2.2) in that the empty, initial consonant slot of the basic CV structure is filled in with articulatory information from a surrounding segment(s). Rather than the articulatory information coming from a segment in the remainder of the word (i.e. from the right), however, it comes from the left for II and IV, namely from the preceding word. The extent to which the different children employ these four options varies. From the realisations of vowel-initial targets, it appears that for some children, in particular Robin (2), the CV structure is more variable and flexible than is the case for Eva (4). Besides CV sequences, CC and VV sequences occur as well. This greater variability in the CV structure of Robin becomes also apparent from the vowel initial realisations that are numerous. The initial syllable template of the child reflecting basic CV structure has developed into a syllable structure that is more flexible and has expanded to make a more variable output possible (see Fikkert 1994). A discussion into the precise nature of the relationship between target, template and realisation is outwith the scope of this section.

#### 7.2.4 Breaking-up and reduction of consonant clusters

Besides non-realisation, and subsequent filling-in of or dummy insertion in the resulting empty consonant slot, one of the strategies for the child to cope with the complex target of initial consonant clusters is to reduce the cluster to units that are manageable for him. A cluster of two consonants, for instance, is realised with an intermediate vowel. Given the basic CV unit, this breaking-up of the cluster is a simple and effective method (cf. Fikkert (1994:105) on epenthesis as a repair strategy). Examples are presented in (8).

(8)	a.	[su'tu:]	<i>stoel</i>	'chair'	/stul/	#7	2
	b.	[mɛlɔkt]	<i>markt</i>	'market'	/mɔkt/	#20	2
	c.	[mɪtə 'sʊlɪf]	<i>met de slurf</i>	'with the (elephants') trunk'	/mɛtə 'slʊrf/	#22	2
	d.	[fɔləkus 'bɛkə]	<i>varkensbeker</i>	('pig mug')	/vɔrkəns 'bɛkər/	#19	7
	e.	[bɔ'lumətɪs]	<i>bloemetjes</i>	'flowers', dim.	/blumɛəs/	#21	7
	f.	[su'vɑ:n]	<i>zwaan</i>	'swan'	/zvan/	#16	7
	g.	[tə'lɛɪn]	<i>trein</i>	'train'	/trɛɪn/	#16	7
	h.	[dɪtə kɔ'lɔk]	<i>dit is klok</i>	'this is clock'	/dɪt ən 'klɔk/	#19	7
	i.	[dɪfɛ bɪ'naʊ]	<i>deze blauw</i>	'this blue'	/dezə blɔw/	#22	7
	j.	[sə'tylə]	<i>sturen</i>	'to steer'	/styrə/	#21	8
	k.	[hə'rɛɪnə]	<i>trein</i>	'train'	/trɛɪn/	#2	9

As becomes clear, especially from longer sequences such as the realisation of *varkensbeker* (d.) and *bloemetjes* (e.), a sequence of CV units offers an alternative for the child in realising a complex/non-simple target. In this context, the realisation of Robin (2) of *dit is een locomotief* 'this is a locomotive' /dɪt 'ɪs ən 'lokomotɪf/ as #19 [dɪt 'ɪsə 'pɔ:pənənə'pʊfɪf] can be regarded as an over-illustration of this point.

Alternatively, clusters are reduced to one consonant only, which is often the stop part of the cluster.<sup>5</sup> This is illustrated by Elke's (9) realisation of *trein* after the first, cluster breaking realisation, as well as Robin's (2) realisation of *stoel* (8a.), presented in (9) (see also below).

(9)	a.	[tɛɪ]	<i>trein</i>	'train'	/trɛɪn/	#4	9
	b.	[tu:]	<i>stoel</i>	'chair'	/stul/	#7	2

Note that the phenomenon of cluster breaking also occurs in adult language. ABN (*Algemeen Beschaafd Nederlands*), the Dutch equivalent of received standard, displays [ə]-insertion so as to create syllables of (more) equal length, resulting in a rhythm that is more clearly syllable-timed

<sup>5</sup> The alternation of the CV strategies cluster breaking and reduction, for example, *stoel* 'stoel' /stul/ [su'tu:] [tu:] #7 2, could suggest that the breaking of a consonant cluster through vowel epenthesis occurs within the scope of the prevocalic C slot. Note that the stress in these child realisations is on the second CV sequence, i.e. on the original vowel, in the majority of cases, and the status of the target vowel has not changed with regard to the main stress. Hind (1997) discusses cases where a CCV- sequence and its epenthesised CVCV- form do not differ in terms of syllable-timing. This agrees with the acquisition data examples discussed, and could contradict the claim in Fikkert (1994:105) that the child creates two onsets in, for instance, [su'tu:] because his template does not allow consonant clusters yet.



(Collins and Mees 1984:214). An example is *melkboer* ‘milkman’ /mɛlkbur/ that through svarabhakti results in /mɛləkbur/. This kind of pronunciation is encountered to a greater extent in dialects of Dutch than in Standard Dutch. They also observe that, similar to the strategies of the children studied here, in Yoruba, one of the major languages in Nigeria, words that are borrowed from other languages ‘are usually changed to conform to the phoneme and syllable structure of the language’ (1984:16). Yoruba only has CV and CV/m/ syllables. In this context, *Christmas* is realised as *kérésimesì*. Japanese too has epenthetic vowels in consonant clusters from loanwords, e.g. *craft* > *kurafuto*, *paprika* > *papurika*, *clockwise* > *kurokkuwaizu* (Lovins 1975:93, 100).

In Basque, cluster simplification has been achieved through cluster breaking as well as through reduction (John Anderson, personal communication). For instance, *iferno* ‘hell’ (cf. Spanish *infierno*) and *eliza* ‘church’ (cf. French *église*). As both French and Italian have clusters in these words, the cluster simplification is regarded as a Basque internal phenomenon. Cluster breaking is illustrated by *liburu* ‘book’ (cf. Latin *librum*) and by *libera* ‘pound’ (cf. French *livre* for both instances). Cluster breaking is also encountered in (the history of) English. For instance, the [xt] <ht> cluster in Old English (<(u)ght> in 13-15th century) is subject to “cluster busting” and vowel epenthesis; CC (OE) becomes CVC (Middle English). Examples are ‘daughter’ *dohter* > *dohuturis*, ‘laughter’ *hleahtor* > *lahuter*, and ‘night’ *niht* > *nyhyt* (Jones 1989:167).

Across the Dutch children the data of which is studied, cluster breaking is observed. Tom (7), in particular, applies this strategy regularly. On the other hand, Jarmo (8) prefers realisations of consonant clusters as a single consonant (see below), and the cluster breaking realisations are near absent in this output.

An alternative to cluster breaking is cluster reduction, i.e. partial realisation. The children studied all realised initial consonant clusters as one consonant, that is the realisation of one of the consonants in the cluster. This strategy too results in a form that is in agreement with the basic CV structure. A few examples are given below.

(10)	a.	[ʔe: 'tue 'di]	<i>een twee drie</i>	‘one two three’	/en 'tue 'dri/	#20	8
	b.	[tuə]	<i>stoel</i>	‘chair’	/stul/	#15	8
	c.	[kikis]	<i>knikkers</i>	‘marbles’	/knikərs/	#19	9
	d.	[kɔkə'diɔ]	<i>krokedil</i>	‘crocodile	/krokə'dil/	#22	2
	e.	[sɛ'nə]	<i>zwemmen</i>	‘to swim’	/zʋemə/	#20	2
	f.	[tɔ'pet]	<i>trompet</i>	‘trumpet’	/trəm'pet/	#22	7

### 7.3 Categorical and articulatory appearance within CV structure

The character of the segments within the structure of CV units takes a generally preferred form, as can be observed in the output data of the five children studied. In terms of the categorical structure, the sequence oral stop + vowel can be regarded as basic. When the categorical structure of the child has developed further, and makes possible CVC realisations, oral stop + vowel + continuant is the main realisation. This does not necessarily mean that these segments are underlyingly specified as stop and continuant, respectively. They can, in the initial stages, be non-specified or specified for a categorically less complex category in the case of the continuants (see 3. for the evolution of the child's early phonological system).

With regard to the articulatory realisation, the basic segment in initial position is labial. In final position, velar appears to be the generally preferred articulatory category. (For a representational implementation of these preferences, see Levelt 1994; also cf. Vihman and Hochberg (1986).) The preference for labial, on the one hand, can be explained by the contrast between stop and vowel in the CV unit. This contrast is assumed to be optimal so as to facilitate initial category differentiation, and 'among the stop consonants, it is the labial sounds which obstruct the entire oral cavity' (Jakobson 1968:69), thus being maximally consonantal (cf. Lass 1976:148, footnote 1). Labial consonants can also be considered maximally different from the vowel in the VC unit as they allow for lingual freedom for the vowel articulation and only involve labial articulation themselves (cf. Sussman 1994). On the other hand, the acoustic characteristics of labial consonants also opposes them to the vowels (in particular the wide *a*-vowel). According to Jakobson (1968:75-76), labials have a dark quality and present the consonantal optimum in terms of chromatism. In Anderson and Ewen (1987), labial segments are characterised by means of the component grave.

So, both on acoustic and articulatory grounds (and visual, see 5.4.2), the labial consonant can be regarded as the optimal consonant, and thus the optimal candidate to contrast with the vowel in the basic CV syllable. Its very consonantal nature and consequently greater perceptibility in combination with the dominance of the basic CV unit in the early stages combine to result in a basic structure that associates labial to initial position on a cognitive level. The early recognition of labial is supported by its early specification, in comparison to alveolar and velar place of

articulation. Within the CVC template, preferences vis-à-vis word position and place of articulation are thus recognised on a cognitive level.

Individual children implement their idiosyncratic preferences and/or limitations in the basic CV structure, possibly overriding the general preferences. (Language specific characteristics are presumably also incorporated in the basic structure of individuals.) For instance, the realisation of final /t/ in the data from Elke (9) during #5-7 is frequently encountered as a stop + continuant sequence, e.g. [t̠ t̠] and [t̠]. This is illustrated by the examples in (11).

(11)	a.	[p̠t̠]	<i>bad</i>	'bath'	/bat/	#5
	b.	[t̠t̠]	<i>stout</i>	'naughty'	/staut/	#7
	c.	[p̠t̠]	<i>kapot</i>	'broken'	/ka'p̠t̠/	#7

For one of the children, the phone [t̠] acquires a special status in the course of the development. Within the context of the basic CV structure, an exceptional application of [t̠] results in a pattern that for a period has a strong influence on the child's output, resulting in realisations with [t̠]V in initial position. Jarmo's (8) data presents a basic structure that contained both categorial and articulatory information (stop and alveolar, respectively). A discussion regarding the possible origin and the effects of this pattern on the realisation of target words, and on the development of the phonological contrasts established underlyingly is presented in 8..

#### 7.4 Conclusion

The five strategies discussed in this section all ensure that the child's output complies with the basic syllable structure during the early stages of acquisition. The realisation of dummy consonants, the filling-in of non-specified slots, the breaking-up and reduction of clusters and also the interaction across words within the utterance are strategies encountered in the acquisition data studied that result in realisations with an overall CV structure. These strategies make it possible for the child to realise target structures that are not within the child's repertoire (or template) yet.

The basic CV structure provides a familiar alternative in situations with new and/or complex targets. This structure thus provides 'stability';

Because stability is important to making sense of the experienced world, young children tend to rely heavily on their established representations ... (Nelson 1986:247).

In fact, it is suggested that the “frame” provided by the CV structure and differentiation therein (see below) can constitute a unified account of development from babbling to adult structure (MacNeilage and Davis 1990).

In the case of Jarmo (8), his established basic structure during the observation period does not only include syllable structure, it also encompasses categorial and articulatory information (namely [t]). He can be said to be more script-bound than the other children whose data did not present a pattern like Jarmo’s (see 8.). In a more general sense, the basic structure of CV units can be seen as a tool for the child to acquire the phonological contrasts in his system. The basic, regular and recurrent structure provides “practice space” to discover the identity of the segments in terms of substitutability, contiguity and similarity (see I3.2). This is illustrated by the realisations in (12).

(12)	a.	[titaʔ diʔtjat də ʔat ʔidap]	<i>is dat</i>	‘is that’	/ɪs ʔdat/	#19	7
	b.	[tata ʔita ʔipa]	<i>auto</i>	‘car’	/oto/	#7	8
	c.	[ʔupi ʔuni hāni ʔēni]	<i>Ernie</i>	name	/ɛ.ni/ (/ʌ.ni/)	#11	8
	d.	[ʔuxə ʔegə̃nə ʔixʁ ʔixə̃nə ʔlixə ʔekə̃lə ʔlixə ʔekə̃nə ʔwexə̃ ʔeikə̃nə]	<i>vlieger tekenen</i>	‘to draw kite’	/vliχər ʔekənən/	#22	7

In this respect, the sequences of CV units in the child’s output relate closely to the event representations and scripts discussed in I3.: they provide a basic structure for the child as his phonological awareness gradually develops, and they enable him to classify perceptual information in a constructive, i.e. functionally relevant, way. The basic CV structure in this context is regarded as the protostructure of the child’s phonological development. The limitations on structural complexity are promoting his phonological development in terms of skills regarding the segmental level, amongst others, as he can now focus on categorial and articulatory contrasts.

## 8. CV protostructure II: case study: categorical and articulatory protostructure - t-pattern.

### 8.1 Variability

The output of Jarmo (8), is characterised by “irregular” realisations in comparison with the data from the four other children taken from the ChildPhon database. These forms are observed both with regard to the adult target, and with regard to the acquired system of the child itself. Whereas child data is characteristically variable, Jarmo’s forms appear to go beyond that and, at first instance, appear to defy analysis in terms of the development of contrasts, which is required in order to establish the evolution of early phonological development, as has been done for the other subjects. In this respect, the data of Jarmo is analysed from a slightly different angle: where a realisation seemed clearly irregular in comparison with all the other forms produced at that session, and in addition, this realisation was analysed as part of a “variable trend” (see below), the individual phones of this realisation are not necessarily all taken into account when establishing the phonological system at that session (cf. Macken 1979:39).

Another aspect of Jarmo’s output that does not promote a straightforward analysis to establish his phonological system is the fact that many words are only realised once. This group of words thus does not offer material that can be used to look at the development of individual words in relation to the development of the overall system, nor is it helpful in establishing the child’s phonological abilities at that session. The main reason for this last obstacle is an idiosyncratic characteristic of Jarmo’s first realisations of words generally, namely that the initial realisations of words are irregular to an exceptionally high degree. As will be shown below (8.2), part of this can be accounted for with reference to an idiosyncratic protostructure manifest in Jarmo’s output that incorporates articulatory information. New words, in relation to the adult target, are more irregular than might be expected on basis of the child’s phonological system and the contrasts therein at the time. (For the evolution of Jarmo’s early phonological system, see 8.4.) After the initial realisation, the word is, in most cases, soon adapted to the system valid at that time (in as far as this is observable, that is, in those cases where a word is not recorded only once). Some examples of irregular first realisations are given in (1).

- |     |    |                |            |            |                      |     |
|-----|----|----------------|------------|------------|----------------------|-----|
| (1) | a. | <i>olifant</i> | ‘elephant’ | /oli,fant/ | [ʔɔʔtu,tat ʔotə,tat] | #15 |
|     | b. | <i>varken</i>  | ‘pig’      | /vaɪkə/    | [kəkʃəs]             | #17 |

c.	<i>dat vogeltje</i>	'that bird', dim.	/dat 'voχəltjə/	['taχ 'koʃɪ]	#20
d.	<i>borstel</i>	'brush'	/bɔɪstəl/	['loʊtoʊ]	#22
e.	<i>wastafel</i>	'washstand'	/vastafəl/	['taχül]	#22
f.	<i>uit vallen</i>	'to fall out (of)'	/œyt, valə/	['ʔœy, fakœ]	#22
g.	<i>olifantje</i>	'elephant', dim.	/oli, fantjə/	['hɔŋi, kaŋjɛ]	#23

Variable forms are also observed amidst many regular forms. These exceptionally irregular realisations are rare within the development of (the realisation of) the words in question. Examples of this group are *beer* 'bear', *uit* 'out', *klaar* 'ready' and *auto* 'car'. However, these words are considered to illustrate the apparently somewhat different status of variable realisations in this child's data.

On basis of the two groups of words discussed so far, i.e. first realisations and exceptional, variable forms, Jarmo appears to attribute a greater importance to the realisation of a word than to the phonetic consistency with which the word is realised. The accuracy of the production of the form in relation to his own system, and thus indirectly the resemblance to the target word, seems to come in second place. In this respect, Jarmo seems to qualify as an (over)ambitious language learner. This, then, is variability from an individual's source rather than from a general source, namely that the reason behind variability is the minimal development of the child's phonological system in terms of oppositions between sounds; it is a variable trend rather than a consequence of the phonological system as such. In order to get a grip on the variability observed, it is necessary to investigate the limits within which variability occurs, and also to look at the history of individual forms (cf. Ferguson and Farewell 1975:429).

Note also that the realisation of Jarmo's utterances appear to be quite easily affected by the complexity of the overall utterance. Whereas individual words are realised in a systematic and stable way, an addition to the utterance resulting in, for instance, a phrase or more complex word can considerably affect the realisation and its regularity. An example illustrating this phenomenon, which generally affects early child language, is *poesje*. Whereas *poes* 'pussycat' /pus/ has a regular realisation comprising an initial /p/ (#2-22) and a final alveolar fricative (#7-22), the realisations for *poesje* are not stable. They are characterised by variability. Examples are given below.

(2)	<i>poesje</i>	'pussycat', dim.	/puʃə/	[pʃjə]	#12
				[ʃju ʃu]	#13
				[ʔyʃjə]	#14
				[tuʃə]	#15
				[puʃə ʔuffə ʔuʃə ʔʃjə ʔuʃə]	#16
				[fʃu]	#17

Besides the words, the realisation of which is affected by the complexity of the overall phrase, another group of words that is characterised by variability is constituted by a few forms that are markedly variant, both in relation to the child's system and the adult target. These forms do not adapt to the developing system in the course of the recording sessions. This small group just remains variant. Examples are *kip* and *haan*, presented in (3a.-b.).

(3)	a.	<i>kip</i>	'chicken'	/kɪp/	[kɪt]	#14
					[tɪt]	#16
					[kɪp]	#20
					[tɪp]	#21
					[ket]	#22
	b.	<i>haan</i>	'cock'	/han/	[hā ʔhām]	#13
					[ʔaɪ]	#14
					[hām]	#15
					[hāmə]	#18
					[hā:m]	#20
	c.	<i>fiets</i>	'bicycle'	/fits/	[hā: ʔhām]	#22
					[fɪʃ ʔiʃ]	#11
					[fɪ]	#12
					[tɪtə ʔtɪts]	#16
					[tɪt ʔdɪtə]	#17
					[ʔsɪts]	#20

The realisations of *fiets* (3c.) have a different status. These forms are also variable in relation to the target. However, prior to variability, the realisations of this word are closer to the adult target than the variable forms in later session. These words are analysed as being part of a much larger phenomenon, centring around [t], that will be discussed in 8.2.

### 8.2 [t]: realisation and function

The overall observation with regard to the development of the three main places of articulation in the earlier session of Jarmo's output is that, initially, the realisation of the oral stops appears to



proceed regularly (#1-14). That is, the variability is similar in nature to that observed in the development of the other four children studied at the comparable time (namely, labial/alveolar/velar, and later alveolar/velar variation; see 5.). First, the opposition labial stop *v.* alveolar/velar stop is established (#8). Eventually /p t k/ are all realised according to the phonemic place of articulation of the target word. This regular picture changes, however, and the stops are realised in a more variable way. The output in #15 is noticeably deviant from that in earlier recording sessions. Different from the realisations before, a large number of words now appears irregular, and their development appears to be “stuck” in a realisation including [t]. In order to gain a better understanding of the phonological structure and development of Jarmo, these [t]-realisations are looked at in detail. The subsequent observations are discussed in 8.2.1-3.

### 8.2.1 *Initial labial segments*

#15 is the first session where [t] noticeably takes over in the child’s output system in terms of, mainly initial, phones. This is compatible with the observation that the word-initial, consonantal position is the slot that the child most actively uses as “practice space” when working on the, in this case, articulatory realisations of his words.

From Jarmo’s data, it becomes clear that there is a certain period during which [t] has a special role that goes beyond that of just a realisation of a contrastive phonological entity at output level. This period extends from #15 up to and including #22 approximately. The rather unusual occurrence of [t], most specifically in relation to the development of oppositions within the early phonological system (see 8.3), is best illustrated by those forms that initially have a labial realisation that is in accordance with the target word, and during the period #15-22 display [t]-realisations. Such forms are presented in Figure 4.

As becomes clear from the examples presented in (4), [t] is favoured in initial position during and after #15. At the time of #14, *bad*, *paard* and *boot* have stabilised in as far as the contrast labial stop *v.* non-labial stop is concerned. The initial consonants of the realisations of these words is [b] or [p], which is within the phonetic space for the articulatory contrast present. However, after #14, these initial consonants are replaced by [t]. Interestingly, the first realisations of *bloemen* and *ballonnen* is after #15, in session #17, and has an initial labial stop; [pʊmō] and [pʊmā], respectively. In the subsequent realisations of these words, however, the t-pattern is implemented.

(4)	<i>bad</i> 'bath' /bat/	<i>paard</i> 'horse' /pa:t/	<i>boot</i> 'boat' /bot/	<i>bloemen</i> 'flowers' /blumən/	<i>ballonnen</i> 'balloons' /ba'lonən/	<i>vis</i> 'fish', sing. /vis/	<i>fiets</i> 'bicycle' /fits/	<i>Willy</i> name /vɪli/	<i>wipwap</i> 'seesaw' /vɪpwʌp/
#1									
#2									
#3									
#4									
#5									
#6		[pɛi 'pa:f 'pa	[pa:s 'pa:ʃ 'ta]						
#7									
#8									
#9									
#10									
#11	[bʌp] ['bɛp]	[pa]							
#12		[pəə 'ba:]							
#13		[pa:]							
#14									
#15		[tʌt]	[tɒt]						
#16	[tʌt]	[tʌt]							
#17	[tʌt]								
#18									
#19									
#20									
#21									
#22									
#23									

\* used especially  
by children

The assumption here is that *bloemen* and *ballonnen* are first attempted on basis of their acoustic properties. Initial labial stop has been mastered by the child, and target /bl/ and /b/ are realised as [p]. As these realisations do not comply with the trend “[t] in initial position instead of a labial”, they are adapted. At #23, *paard* appears to have shaken off the [t]-dominance, and has re-established a labial initial segment. This is expected to happen for the other words in this group as well.

With regard to the initial fricatives of *vis* and *fiets*, it becomes clear from the realisations in #8-12 that these have not stabilised yet. (Note the use of initial dummy consonants [ʔ h].) This is not what is expected on the basis of the development of the other Dutch children studied (see 3.). Namely, the opposition between alveolar and velar fricative is stable at #15, whereas the labial v. non-labial fricative contrast is not established before (or at) #15, which would, regularly speaking, be the case. At #15, *vis* and *fiets* are both realised under the t-pattern. (*fiets* is realised as [ditə] in #17. As [t] and [d] are realisations of the same phonological entity, [d] will be considered a regular instance of a t-pattern realisation when occurring in the appropriate environment, as is the case here.) A similar development can be observed for the liquids in *Willy* and *wipwap*. However, the difference is that these labial segments in initial position, before being replaced by [t] from #15 on, appear to have been mastered as labial liquids.

With regard to *wipwap* and *Willy*, they are also categorised in this group. The realisation of *wipwap* presents a change from labial liquid to alveolar liquid and [t] over time. And thus conforms to the t-pattern. The initial liquid in *Willy*, however, appears to have been stabilised to such an extent that the categorial realisation as liquid is maintained, and the adaptation to the t-pattern only involves the articulatory value. Note also that at the time the liquids did not display intra-categorial oppositions. However, the individual word *Willy* seemed to have stabilised with an labial liquid in initial position before the t-pattern era.

As becomes clear from (4), the child apparently has a “view” on word structure that does not allow for labial segments in initial position. The origin of this (mis)understanding is on a cognitive rather than on an articulatory or phonological level, as initially, labial segments do occur in that position, before the coming into existence of the t-pattern, and the opposition labial v. non-labial has stabilised for the stop category. The child’s difficulty in recognising and realising initial labial

fricatives appears to lead to the t-pattern as evidenced in his output. The source of the t-pattern for this group of words is thus suggested to be the failure to recognise the opposition labial v. non-labial fricatives (see 8.3).

Furthermore, at the time that the oral stop category has a three-way opposition for place, the fricatives only have the opposition alveolar v. velar. This two-way opposition seems to be extended to the stop category as the occurrence of [t] in initial position extends to all labial segments in initial position. The ban on labials in this slot, and the subsequent realisation as [t] lay at the root of the variable realisations in Jarmo's output regarding this group of words. The extension of the two-way articulatory contrast in initial position to the stop category has as a consequence a regression of the system. The result, and possibly motivation for this extension, however, is symmetry in the child's underlying system.

### 8.2.2 *Complex structures*

On a more general (non-labial) level, [t] is observed in the initial realisations of complex new words, given the child's categorial structure of the words realised at the time. Also, with regard to the articulatory development at the same time, segments in the adult target that have not established yet in the child's system are realised as [t]. Examples of categorially, rather than articulatory, complex targets, including clusters, that are realised by Jarmo employing [t] are given below.

(5)	a.	<i>olifant</i>	'elephant'	/oli,fant/	[ʔotroʊt 'totaut]	#19
	b.	<i>nijlpaard</i>	'hippopotamus'	/neil,pa:t/	[tʉpɛə]	#15
	c.	<i>schildpad</i>	'turtle'	/sʃil,pat/	[tʃta:t 'teitāt]	#15
	d.	<i>zebra</i>	'zebra'	/zebra/	[teta:t]	#15
	e.	<i>tandenborstel</i>	'toothbrush'	/tandə,bɔ:stəl/	[tata:tʃut/tʉ]	#15
	f.	<i>vasthouden</i>	'to hold'	/vast,haudə/	[tʉtaʉʉə 'tʉtʉaʉʉə]	#18
	g.	<i>dat ook stuk-</i> <i>maken</i>	'to break that too'	/dat ʔok 'stukmakən/	[ta ʔo 'tʉstakə]	#19

The syllables in the target words are systematically realised as [t]V(C) in cases of complexity. The child has thus found a way to cope with a structure that within the abilities of his system can not yet be realised as a form that closely relates to the adult target. This "default syllable" makes it possible for him to realise the word. In this context, the use of [t] and the use of glottal stop and [h] as dummy consonants have similarities. (See 8.2.3 below.)

A similar strategy is applied to words triggering [k], rather than [t]. Here too, the complex structure is initially realised as a sequence of stop + vowel (+C) sequences, reflecting the syllable structure of the adult target. Examples are given below. This phenomenon, involving [k]V, however, does not develop into a widespread pattern, as [t]V does.

(6)	a.	<i>kleine staart</i>	'small tail'	/kleinə'staɪt/	[kɛi,kas]	#19
	b.	<i>klok maken</i>	'to repair clock', 'to make clock'	/klɒk 'makən/	[kɔχ 'kakə]	#19
	c.	<i>kapot maken</i>	'to break'	/ka'pɒt 'makən/	[kɔ,kaku]	#18

### 8.2.3 Conclusion

[t] is concluded to have a special role in the output of Jarmo, on the basis of the examples discussed so far. [t]V appears to be a basic unit in his realisations that is applied in different situations. Firstly, it provides a default syllable in cases of overall complex words (8.2.2). Whereas the number of syllables in the target phrase is reflected by the child's utterance, the articulatory and/or categorial characteristics are simplified to [t]V(C). This strategy enables the child to realise the complex word or phrase. Secondly, with regard to the labial segments in the target words, these are closely related to the occurrence of [t] in the child's realisations (8.2.1). Initially (< #15), labial segments occur in initial position (mainly oral stops). Later, however, the realisation of labial segments in this position becomes rare as they are mostly realised as [t]. Apparently, the child has not developed a cognitive understanding of, and subsequently a phonological opposition including, labial fricatives. The impact of this cognitive and underlyingly phonological issue results in an almost complete absence of initial labial segments in the output for a certain period (#15-22). Words that are realised with an initial labial before #15, in accordance with the articulatory value of the target word, later conform to the t-pattern phenomenon, and are realised with initial [t] (see 8.2.1). Here too, [t] can be regarded as a default realisation as it starts out in the place of something the child's underlying system can not cope with.

The t-pattern thus comes into existence from two different backgrounds: a default syllable [t]V(C) that is realised to cope with complex words, and a "ban" on labial segments in initial position. These different sources, however, have in common that the [t] functions as a default segment. This shared default mechanism enables the child to cope with adult targets, the realisation of which he

has not fully mastered yet (in adult terms), and it also reinforces the influence of the t-pattern in the child's output.

Two diachronic patterns emerge in Jarmo's data that are each other's mirror image. On the one hand, the initial realisation(s) of a great number of words by Jarmo is widely variable and/or realised on basis of the t-pattern. These forms develop towards a more "regular" realisation in terms of Jarmo's system, and indirectly in terms of the adult target. The second development, on the other hand, displays regular forms at first, and then shifts to t-pattern realisations. These patterns do not necessarily occur in the same set of recording sessions. Whereas the first group employs the [t]-realisation in the context of variability, at a time when the child has to cope with difficult information, and the t-pattern offers an easier alternative, the latter group adapts to the current pattern and thus to system-internal regularity ("no labial in initial position"). Overall, from the point of view of the observer, this results in quite a chaotic pattern in the realisation of place of articulation.

The question regarding the underlying representation of [t] in the t-pattern is an interesting one. Given the analysis of [t]V as the basic unit of the t-pattern, and the possibility to have a number of these units constituting the realisation of a word, [t] appears to be part of a pattern that is imposed on the child's realisation. That is, [t] does not appear to interact with the structure of which it is part. Also, [t] does not seem to be acoustically motivated. Its existence can be regarded as originating at the cognitive level (see above). On these grounds, [t] in the t-pattern realisations can be regarded as an entity that is impermeable in nature, the phonetic character of which is of no relevance at the phonological level in the form of an underlying specification.

From the pre-systematic labial realisations (see 8.2.1, Figure 4) that have an initial labial stop at a time that the labial v. non-labial opposition for oral stops has stabilised, it can indeed be concluded that the t-pattern involves replacement at the phonetic level. *Bloemen* and *ballonnen* illustrate that this contrast is still valid when the t-pattern determines Jarmo's output. However, when it concerns a [t]-realisation for segments that are still difficult for the child, and are not established underlyingly, these segments are not specified. As a consequence, [t] appears in the output of Jarmo not as a result of replacement, but as a result of imposing a [t] specification in an otherwise empty articulatory gesture. In this respect, [t] has a similar role to the dummy



consonants glottal stop and [h] (see 6.). The difference being that [ʔ h] are characterised by the absence of articulatory information, whereas [t] is specified underlyingly (#14 alveolar *v.* velar stop). As there is no evidence of a (clear) interaction between default [t] and the rest of the structure, this difference has no consequences for the theory.

The default status of [t] in Jarmo's data does not appear to be clarified by the assumption of coronal underspecification (see 4.). It is only after the contrast alveolar *v.* velar stop that the t-pattern is imposed on a large scale. It is possible to envisage an explanation of the t-pattern on basis of non-contrastivity and non-specification. Suppose that velar is in contrast with non-velar, and thus that velar is specified and labial/velar form a non-contrastive, non-specified entity. In this situation, the neutralisation of place in initial position would amount to coronal non-specification, and the occurrence of [t] in the case of complex or initial, labial target structure is thus likely. However, the contrast velar *v.* non-velar would be expected to give rise to velar filling-in (cf. labial filling-in), which is not encountered. Non-specification and underspecification of coronal are thus both rejected. [t] is assumed to be imposed on the existing articulatory contrasts, on a phonetic level, and to function as default segment in non-specified segment slots. The t-pattern is assumed to be cognitive in nature, rather than phonological.

To conclude, the different groups constituting the variability in Jarmo's output discussed in 8.1-8.2.2 are presented in (7). Variability is considered in relation to the child's phonological system at the time and also in comparison with the adult target.

- (7) A i. initial realisations.  
       ii. exceptional, variable forms.  
       iii. variant forms.  
       B iv. adapted [t]-realisations; in particular, initial labial consonants.  
       v. t-pattern - first realisations and complex targets.

The sub-groups in (7A) illustrate that variability in Jarmo's data appears to occur as the price for a realisation as such (pay-off principle) (i. and iii.). Also, even amidst regular forms, variable ones occur (ii.). With regard to (7B), initial [t] has a special role within the context of the t-pattern. The function of this pattern can be regarded as follows. The absence of the cognitive acknowledgement that the continuant category also displays a split on the articulatory level, as is the case for the nasals and stops, precludes an opposition labial *v.* non-labial for this category. It is suggested here



that this results in the absence of initial labial fricatives in the child's output, and subsequent realisations of [t] that acts as default segment. This absence of labial realisations in initial position is extended to other labial categories. As a consequence labial segments in initial position that are already mastered are replaced and realised as default [t]. The occurrence of [t] for a segment that apparently is difficult for the child to realise is related to the realisation of generally complex structures. [t]V functions as a default unit that provides an alternative form for difficult targets for Jarmo (8.2.2).

### 8.3 Development of phonological contrasts

The realisation and function of the [t]-forms in Jarmo's data have been discussed in 8.2. In this section, the development of his phonological system in terms of oppositions is considered. The four categories distinguished within the categorial gesture are discussed regarding place of articulation.

The nasals display a straightforward development that can be regarded as regular in comparison with the data from the four other Dutch children. At #12, the contrast labial v. non-labial nasal stop is established, i.e. /m/ v. /n ɲ/. Consequently, labial is specified for the nasal category. This is evidenced by the labial filling-in process illustrated by the following examples in (8) (see also 5.2.3).

(8)	a.	<i>ander boek</i>	'another book'	/ʌndəɪ 'buk/	[ʔam puk]	#21
	b.	<i>een bord lepel</i>	'a plate spoon'	/ən 'bɔɪt 'lepəl/	[ʔəm 'pɔɪs 'lepoʊ]	#21
	c.	<i>ballonnen</i>	'balloons'	/bʌ'lɔnən/	[tɔmɔ]	#19

The non-labial nasals do not develop a contrast before #23, which is the last recording session.

The initial development and realisation of labial appears regular. The opposition labial v. non-labial is established first, for both nasal and oral stops. #8 is concluded to have a stable labial oral stop category that is therefore specified. As with the nasals, this offers the possibility of labial filling-in of articulatory non-specified segments. This can be observed in the final position of the *bad*, *boek* and *paard hier*.

(9)	a.	<i>bad</i>	'bath'	/bat/	[bɛp 'bap]	#11
	b.	<i>boek</i>	'book'	/buk/	[bup]	#12
	c.	<i>paard hier</i>	'horse here'	/part hir/	[pap 'hiə 'pap 'hiɪ]	#12

At #14, the opposition within the domain of the articulatory gesture between alveolar and velar is established for oral stops as well as for fricatives. The t-pattern does not appear to affect the contrasts for this group. So, when the t-pattern is imposed on initial labial consonants, in #15, the alveolar place of articulation is specified.

The group that is most drastically affected by the t-pattern is the labial fricative category (see 8.2.1, 8.2.3). Initially, a few instances of labial fricatives are attempted. These do not establish a labial v. alveolar/velar contrast, which is observed for the other four children. In medial and final position, /f v/ are realised as alveolar. Examples are *koffie*, *duif* and *duiven* in (10), which are all first and only occurrences.

(10)	a.	<i>koffie</i>	'coffee'	/kɔfi/	[kɔsi]	#15
	b.	<i>duif</i>	'dove'	/dœyf/	[dœys]	#11
	c.	<i>duiven</i>	'doves'	/dœyvən/	[dœysə]	#11

It is only in initial position that a labial fricative is sporadically realised in a word with a labial fricative target, namely in *vogel* and *fiets*. (For *fiets*, see 8.1, (3c).) These words, however, are subsequently realised with initial [t], thus satisfying the ban on initial labial consonants. This gives rise to a period in which the child's output has a near absence of initial labial fricatives. (In the instance of *meer vogel* 'more bird' /mer 'voχəl/ #17, the issue is evaded by means of metathesis [mi 'kofoŭ].) In this context, it should be noted that in cases where the development of the t-pattern and its effect on the realisation of particular groups of phonemes is investigated, it is more informative to look at the realisations of individual words and the sessions during which the t-pattern is active for these words. A similar development can be observed in different words, though not necessarily coinciding in terms of recording sessions.

The (near) absence of labial fricatives referred to above is at a time when the other children have actually established an opposition labial fricative v. alveolar/velar fricative. The contrast between alveolar and velar fricatives for Jarmo appears to have stabilised at #15. At #21, labial fricative is on the scene again. /f/ is realised as [f], /v/ is realised as [f] or as alveolar fricative [s]. However, the labial fricative does not stabilise until and including the last recording session of this child.

The near absence of initial labial fricatives during #15-17 provides an articulatory-based reason underlying the emergence of the t-pattern.

The [t]V dominance in Jarmo's production is reinforced by the [t] realisation of initial alveolar continuant targets. At a time when these segments are not mastered yet, [t] is realised in initial position (e.g. *Rollo* (product) name of sweet /rɔlo/ #22 [doloʊ̯]; note that [d] and [t] are regarded as being realisations of the same phonological entity (cf. 8.2.1)), or when an initial consonant cluster is reduced (e.g. *stoel* 'chair' /stul/ #15 [tuə], #16 [tu'tu]), or when an empty slot of a target cluster is filled-in (e.g. *vliegtuig* 'aeroplane' /vliχtœyχ/ #18 [titœyf]). On basis of the non-stability of alveolar continuants at the time, especially liquids, and the complexity of cluster targets, these forms are not unusual or unexpected.

The occurrence of liquids in relation to the t-pattern phenomenon is clearly affected in the realisations of *Willy* and *wipwap*, discussed in 8.2.1. During #17-19, initial [v] is not observed. Instead, t-pattern realisations for *water*, *wortel* and *worm*, for instance, are encountered, and presented in (11). Within the category of the liquids, no contrasts are stabilised.

(11)	a.	<i>water</i>	'water'	/vatəɪ/	[tʲatə]	#17
	b.	<i>wortel</i>	'carrot'	/vɔrtəl/	[tatəw]	#18
	c.	<i>worm</i>	'worm'	/vɔrm/	[tʃjɔm]	#19

#### 8.4 Evolution of the early phonological system of Jarmo

On basis of the discussion in 8.1-3, the evolution of the early phonological system of Jarmo (8) has been constructed. The development of contrasts has been considered in detail because Jarmo's realisations are characterised by a high degree of variability, as well as by many realisations with initial [t]. This t-pattern has been concluded to evolve from the lack of recognition of labial fricative category on a cognitive level. [t] is realised in initial position instead. The absence of labial segments is extended to all categorial classes, and the t-pattern is imposed on all realisations during #15-17. The unit [t]V also functions as a default unit for complex targets.

The overview of Jarmo's evolution is presented in (12). This Figure complements the discussion of the phonological development of the other children, discussed in 3.. As Jarmo's system does not display a labial v. non-labial distinction for the liquid category, a third shaded band is absent.

(12)

8 Jarmo

#1	stop	
#2	stop	
	cont	
#3		
#4		
#5		
#6	nasal	
	stop	
	cont	
#7		
#8	nasal	
	lab stop	stop
	fricative	
	liquid	
#9		
#10		
#11		

#12	lab nasal	nasal	
	lab stop	stop	
	fricative		
	liquid		
#13			
#14			
#15	lab nasal	nasal	
	lab stop	alv stop	vel stop
		alv fric	vel fric
	liquid		
#16			
#17			
#18			
#19			
#20			
#21			
#22			
#23			

## 9. Reduplication: use of the protostructure

### 9.1 **Reduplication and other strategies**

The most striking feature in the data of the two English children studied (Cruttenden database) is the relatively large number of  $C_xVC_xV$  realisations of a target form which contains two or more CV(C) syllables, with non-identical consonants. As reported in the literature, a  $C_xVC_{(x)}(V)(C)$  structure in the output of the child can arise as a consequence of reduplication, consonant harmony and protostructure strategies. In this section, these child language processes are discussed in relation to the Cruttenden data (9.2), and also compared with one another (9.1). Firstly, the basic descriptions of these phenomena are given below.<sup>1</sup>

A child realisation that has the form CVC(V)(C) can be the result of reduplication, or of a protostructure strategy:

#### *reduplication*

complete reduplication involves repetition of the first (and only) syllable of a child's word, which is usually the stressed syllable of the adult target, to constitute the following, second syllable. Partial reduplication involves either C or V.

Examples:    *mirror*                    [mɪmɪ]                    /mɪrə/

*blanket*                    [ˈbʌbə]                    /blæŋkət/    (Grunwell 1982:171-72).

#### *protostructure strategies*

the CV protostructure constitutes a practice space for the child and a tool to acquire the phonological contrasts in his system. Strategies that are employed to attain this protostructure are, for instance, the realisation of dummy consonants, the filling-in of non-specified segment slots, the breaking-up of clusters, and across-word interaction.

Examples:	<i>aap</i>	[ʔa:p]	/a:p/	‘monkey’	2	#5
	<i>even draaien</i>	[hejə]	/evən/	‘just’	8	#23
	<i>sloffen</i>	[pɔfə]	/slɔfə/	‘slippers’	4	#5
	<i>aapje</i>	[ˈwʌpʃ]	/apjə/	‘monkey’, dim	7	#11
	<i>zwaan</i>	[suˈva:n]	/suan/	‘swan’	7	#16
	<i>gaat even rijden</i>	[ˈχaˈtɛfə]	/χatˈevən/	‘goes for a while’	2	#21.

<sup>1</sup> Cf. the discussions in the following sections: I6., I7. and II7..

Individual children can develop a “personalised” protostructure that contains categorial and/or articulatory information. Such a wordpattern often satisfies the basic CVCV structure. For a detailed discussion of an individual child’s pattern, see 8..

Both reduplication and consonant harmony are “processes” that can result in a structure with two similar consonants. Consonant harmony ensures place (and/or manner) agreement between two non-contiguous consonants that are different from the target consonants in that respect, for example, *coat* [‘kok] /kəʊt/ (Iverson and Wheeler 1987:252). It is a process that involves only the consonantal segments in the child’s form.<sup>2</sup> Complete reduplication and consonant harmony can only be distinguished on the basis of the vowels in the realisation.

(1) a.	<i>mouse</i>	[mʌmʌ]	/maʊs/	J	#4
b.	<i>medicine</i>	[mʌmi]	/medsən/	J	#4

In accordance with the definitions, [mʌmʌ] for *mouse* is an example of reduplication, whereas [mʌmi] for *medicine* is not because of the lack of identity between the vowels.

This distinction gives much importance to the identity of the vowel, which subsequently raises questions about the distinctions the child makes, phonologically and phonetically, with regard to vowels. Reduplication is considered to be a phonological process (Grunwell 1982, Ingram 1974a, 1976). On the one hand, it is assumed here that the “easiest” realisation, i.e. the least complex realisation in terms of production, for the child is a realisation that involves a repetition of the articulatory movements, thus resulting in identical syllables, and thus identical vowels. On the other hand, if the child has a phonological representation of two identical syllables, these need not necessarily be realised similarly, within the boundaries of the child’s phonemic categories or contrasts present in his system at the time.

A similar rejection of reduplication is illustrated by Jane’s realisations of *table* as [tedəʊ]. However, voicing is not contrastive at #10 in Jane’s system, and as such the two realisations of *table* can be regarded as identical.

(2) a.	<i>table</i>	[te:tu:]	/teɪbəl/	J	#8
b.	<i>table</i>	[tedəʊ]	<i>idem</i>	J	#10

<sup>2</sup> Levelt (1993, 1994); and Iverson and Wheeler (1987) have reanalysed consonant harmony as vowel-consonant harmony; see I.6 and II.2.1.2. However, examination of the realisation of place has made it clear that VC harmony constitutes a rather small part of the harmony cases (III.7.).

From this perspective, strictly speaking, the assignment of the label “reduplication” needs to take into account the contrasts valid for the child’s system, when considering a  $C_xVC_xV$  output form. (These contrasts are: #1 nasal v. labial stop v. stop, and #8 labial nasal v. nasal v. labial stop v. stop v. fricative v. liquid.)

(3) a.	<i>cuddle</i>	[kʌku]	/kʌdl/	L	#8
b.	<i>lady</i>	[lɜ:lɛ]	/leɪdi/	L	#1

The above realisations of *cuddle* and *lady* appear to illustrate partial (consonant) reduplication as well as consonant harmony. No distinction can be made between these two processes or analyses.

In forms like [papa] or [pʌpə] for *supper* /sʌpə/ J (#6, 11, respectively), consonant harmony can account for the identity of the consonants. An analysis on the basis of reduplication, complete in the case of [papa], would have to mention the observation that the unstressed syllable rather than the stressed syllable in the adult target has been reduplicated. However, as such, the /p/ probably constitutes a more salient characteristic for the child than the /s/, thus overriding the saliency of stress placement.

On the whole, the identification of the “processes” to account for child forms like  $C_xVC_xV(C)$  is not straightforward. The distinctions between the definitions of the different phenomena are generally small, and the data that is presented as an illustration of these phenomena appear to overlap. Also, and perhaps more importantly, the motivation on the part of the child to realise, for instance, *supper* as [papa] or [pʌpə] requires consideration. Let us first consider the motivation(s) for the different phenomena defined above.

The basic CVCV protostructure offers a familiar structure to the child that enables him to realise complex words, both with regard to syllable structure and to segmental information. “Practice space” is provided by the basic, regular and recurrent structure to recover the identity of the segments in terms of substitutability, contiguity and similarity.<sup>3</sup> The child will actively apply strategies to achieve such a structure, for instance, cluster breaking, dummy consonants and across-word interaction (as discussed above).

Consonant harmony also gives rise to a less complex form for the child to handle. Vihman (1978:328 based on Menn 1974) suggests that forms showing consonant harmony with the

<sup>3</sup> See I3.2, and II7.4.



redundancy regarding the repeated consonants 'simplif[y] the child's mnemonic problems in recording and storing a rapidly growing lexicon' (see I6.1). The proposals concerning consonant harmony discussed in I6. all relate to the child's limited abilities (to differentiate between segments at different hierarchical levels, to time different articulators, to store segmental information, etc.). Reduplication reflects the limited abilities of the child as well; whereas he is not able to realise a target with a complex syllable and/or segmental structure, he can identify the most salient (part of the) syllable and repeat this to approximate to the syllable structure of the target (I7.).

The distinction, as presented in the literature, between reduplication and consonant harmony appears difficult to maintain in that different analyses apply to the same child utterance. These two "processes" can both produce the  $C_xVC_xV$  form that is characteristic in the data from Jane and Lucy (Cruttenden corpus). They can also be regarded as similar in their motivation to employ the basic structure, as can the protostructure strategies mentioned, namely to enable the child to produce a realisation of a complex target that he has not completely mastered yet. Before discussing the usefulness of the various distinctions between the child processes (9.3), the data of Jane and Lucy is considered first.

## 9.2 Data

### 9.2.1 $C_xVC_xV$

The following discussion illustrates the data from the two English children (1;5.17-2;5.16) that has been analysed. (For a discussion of the development of phonological contrast, see 3.). The emphasis is on the  $C_xVC_xV$  forms in their output, and the following three categories are distinguished:

- i)  $C^1_xV_yC^2_xV_y$ ,<sup>4</sup> where the consonant of the first syllable,  $C^1_x$ , correlates to the (or a) consonant in the onset of the stressed syllable in the adult target ("reduplication") (examples Ia.-i. below).
- ii)  $C^1_xV_yC^2_xV_y$ , where the consonant of the second syllable,  $C^2_x$ , correlates to a consonant in the adult target (reverse "reduplication") (examples IIa.-c.).
- iii)  $C^1_xVC^2_xV$ , where either  $C^1_x$  or  $C^2_x$  correlates to a consonant in the adult target (examples IIIa.-s. L→R, IIIt.-y. R→L).

Differentiation between the data from Lucy (L) and her sister Jane (J) is only made where their data significantly differs.

<sup>4</sup> The numbers refer to the order of the consonants in the child's utterance.

(4) I				
a.	<i>all finished Lucy</i>	[lulu]	/lusi/	L #10
b.	<i>doctor</i>	[dɔʊdɔʊ]	/dɔktəʳ/	L #3
c.	<i>Lucy marmelade on her toast</i>	[təʊtəʊ]	/təʊst/	L #14
d.	<i>nice</i>	[naimaɪ]	/nais/	L #4
e.	<i>piggy</i>	[pʰi:pʰi:]	/pigi/	L #1
f.	<i>all gone biscuits</i>	[bibi]	/biskɪt/	J #13
g.	<i>daddy's glasses</i>	[gaga]	/glɑ:siz/	J #8
h.	<i>parcel</i>	[pʰäpʰä]	/pa:səl/	J #5
i.	<i>pocket</i>	[papa]	/pɔkɪt/	J #7
II				
a.	<i>woman</i>	[mi:mi:]	/wʊmən/	J #2
b.	<i>crispies</i>	[pʰipʰi]	/krɪspɪz/	J #6
c.	<i>supper</i>	[papa]	/sʌpəʳ/	J #6
III				
a.	<i>birdie</i>	[bə:bi bə:bi:]	/bɜdi/	L #1
b.	<i>chocolate</i>	[kɔki]	/tʃɔklət/	L #8
c.	<i>cuddle</i>	[kʌku]	/kʌdl/	L #8
d.	<i>grandpa</i>	[gɒ.gə]	/grænpa:/	L #8
e.	<i>lady</i>	[lɜ:lɛ]	/leɪdi/	L #1
f.	<i>nose</i>	[nɔ̃ni]	/nəʊz/	L #4
g.	<i>birdie</i>	[bə:bi]	/bɜdi/	J #6,8
h.	<i>bucket</i>	[pəpi]	/bʌkɪt/	J #4
j.	<i>chocolate biscuit</i>	[kɔki kɔki]	/tʃɔklət/	J #8
k.	<i>cuddle</i>	[kʌku]	/kʌdl/	J #11
l.	<i>kitchen</i>	[kɪki]	/kɪtʃən/	J #8
m.	<i>lady</i>	[lɒli]	/leɪdi/	J #3
n.	<i>little baby</i>	[lɔlu]	/lɪtɪ/	J #13
o.	<i>naughty girl</i>	[nɔ:ni]	/nɔ:ti/	J #10
p.	<i>pencil</i>	[pu:pu]	/pensəl/	J #2
q.	<i>Suki</i>	[su:si]	<i>name</i>	J #8
r.	<i>water</i>	[wɔwə]	/wɔ:təʳ/	J #6
s.	<i>spider</i>	[pʰaɪpʰə]	/spaɪdəʳ/	J #10
t.	<i>rabbit</i>	[bʌbi]	/ræbɪt/	L #1
u.	<i>chicken</i>	[ki:ki]	/tʃɪkən/	L #3
v.	<i>rhubarb</i>	[bu: bæ]	/ru:bɑ:b/	J #10
w.	<i>lunchtime</i>	[tə:tʌm]	/lʌntʃtaɪm/	J #6
x.	<i>moo cow</i>	[ku:kau]	/mu: kau/	J #10
y.	<i>teapot</i>	[pi:pɔ]	/ti:pɔt/	J #8

The C<sub>x</sub>VC<sub>x</sub>V forms presented here are realisations for more “complex” targets that contain consonant clusters, consonants belonging to more vowel-like natural classes, or, it is assumed here, sequences of segments that the child can not cope with yet. In Lucy’s data, these forms occurred between #1-14, Jane’s forms occur between #2-17. This is in agreement with the expectation that

the reduplication/consonant harmony forms will disappear when the child's production and perception abilities increase and more contrasts are established in his phonological system

The rationale of the realisation of these target words appears rather straightforward: that part of the target that the child recognises, is realised in place of, and rather than, what she finds more and/or too difficult. Amongst the segments from the target words that are not realised, in favour of a CVCV form with two identical consonants, nasals and labial segments are absent. In the slots of the "absent" segments, the greater majority of the segments realised are stops, and, for Lucy, also labial segments. This confirms the early prominence and stability of nasals, stops and the labial place of articulation.

With regard to the direction of the replacement, i.e. the position (before or after) of the consonant that is present in the target word and child's realisation in relation to the segment(s) that are not realised, there is a bias towards "left to right" (L→R), for both "reduplication" and consonant harmony. Still, the R→L cases do not appear to be motivated differently, and although less frequent, there does not appear to be a valid reason why they should not come under the same heading as the L→R cases. A possible explanation for the bias in the direction could be related to the syllable template of the child. Syllables in the target word that carry primary stress are more salient to the child than those that do not, and are thus more likely to be selected by the child. In combination with the disyllabic template of the child that prescribes initial stress, observed in both Fikkert (1994:298) on the basis of the ChildPhon data, and Ingram (1978, as reported in Fikkert 1994:196). This disyllabic template with initial stress follows the first, monosyllabic template. This might generally explain the bias of direction in the output of Lucy and Jane with regard to their "reduplication"/consonant harmony forms.

Other, related phenomena that are illustrated in the Cruttenden data are the CVCV-creating strategies. For instance, the realisation of a dummy consonant in initial position in the child's form for *apple* and *all gone*:

(5) a.	<i>apple</i>	[p <sup>h</sup> ap <sup>h</sup> a]	/æpəl/	L #1
b.	<i>apple</i>	[ba:p <sup>h</sup> u:]	<i>idem</i>	J #4
c.	<i>all gone</i>	[gɔgɔn]	/ɔ:l gɔn/	J #9

The forms in the English acquisition data relating to these strategies are discussed in 10., in conjunction with the discussion regarding the development of place of articulation in the two data sets from Jane and Lucy.

When comparing the targets that are realised as  $C_xVC_xV$  forms from the data of Lucy and Jane, an overlap of target words can be observed; *ready*, *parcel*, *lady*, *chocolate* and *birdie* occur in both data sets with similar identical consonants. Given that the children at the time of recording were growing up together as twin sisters, the choice of target words (for which the immediate environment is important, see Gillis and de Schutter 1986) is not surprising, nor is the similar choice of realisation "strategy" in this context. Anyway, most realisations in terms of the identity of the consonants are expected: [p] for *parcel* (Ih. in (4) above), [k] for *chocolate* (IIIb.) and [b] for *birdie* (IIIa.). The reduplicated [v] for *ready* in [vɛvi] /redi/ J #6 reflects the [v/r] variation observed for both children. On basis of the Cruttenden corpus alone, it is not clear to what extent this is an idiosyncratic feature or regular development in the acquisition of English. For *lady* (III m.), the repetition of [l], rather than [d], is unexpected rather than regular. However, both children also have a IVIV realisation for *another/other*:

(6) a.	<i>another butter</i>	[lɛlɔʊ]	/ənʌðəʔ/	L #11
b.	<i>basket another</i>	[lɛlɔʊ]	<i>idem</i>	L #8
c.	<i>another fly</i>	[lɛlɔʊ]	<i>idem</i>	J #10
d.	<i>other one</i>	[lɛlɔʊ]	/ʌðəʔ/	J #9

Given the reduplicated form for *Lucy*, one of the subjects, as [lulu], both as child form and target, it is assumed that the [l] segment was a salient feature for the two children. It is hypothesised that this both influenced the overall development of phonological contrasts (see 3.), as well as the promotion of the wordpattern IVIV.

### 9.2.2 Cruttenden (1978)

The discussion on assimilation and deapicalisation in Cruttenden (1978), which is based on the data from Lucy is considered here again. (For a discussion, see I6.2.3). Cruttenden (1978:373) claims that the three basic places of articulation relate to one another according to the following assimilatory strength hierarchy: labial > velar > apical, on basis of the consonant harmony forms in Lucy's data.

Firstly, it is stated that, at the onset of the selected period (1;6-2;2), the 'sound system' of the child consisted of /p b t d k g m n l s ʃ/, and that /f ɲ/ and /w/ were added 'during the early part of the period' (1978:373). On the assumption that 'sound system' refers to phonological system, this statement is not in agreement with the development of phonological contrasts that is proposed here on basis of the data from Lucy. At the end of the first month of recording (last recording session 7-11-68), Lucy is aged 1;6.17, according to the database. The phonological oppositions for #3 (18/11/68) are assumed to be nasal *v.* labial stop *v.* stop *v.* continuant (see 3.).

So, although the phonemes mentioned by Cruttenden (1978) occur as sounds in the output, they do not have contrastive status. Also, mainly, and presumably as a consequence of the assumption that the child's system is so rich, Cruttenden (1978) refers to all discrepancies between the consonants in the target and in the child's realisation as assimilation. Although the three places of assimilation are concluded to have different assimilatory power, the (changing) developmental relationships between labial, alveolar and velar are not acknowledged. On basis of the data analysis and the resulting development of contrasts proposed here, both the uniform assimilation status of the different forms and the strength hierarchy are rejected here. (On the early establishment of labial, and the relation between [t] and [k], see 10.1).

Below, a few examples presented in Cruttenden (1978:374) are analysed in the light of the contrasts present in the phonological system at the time of utterance, to illustrate the varied status of the 'consonant harmony' forms.

					<u>contrasts</u>	
(7)						
a.	<i>button</i>	[bʌpə]	/bʌtn/	: labial filling-in	lab stop <i>v.</i> stop	L #6
b.	<i>man</i>	[mʌm] <sup>5</sup>	/mæn/	: free variation	nasal	L #1
c.	<i>dog</i>	[gʌgi] <sup>6</sup>	/dɒg/	: free variation	lab stop <i>v.</i> stop	L #1,3,5
d.	<i>water</i>	[wɔwə]	/wɔtəʔ/	: complexity		L #4
			(see example <i>water</i> in 9.3 below)			

### 9.3 Summary

From the C<sub>x</sub>VC<sub>x</sub>V forms in the data of Lucy and Jane (9.2.1), it is evident that the target words are more complex than their realisations. This complexity in combination with the child's limited abilities to perceive, represent and produce can be regarded as the reason behind the child's more

<sup>5</sup> [mæm] in database (recording date 22/10/68).

<sup>6</sup> *doggy* in database (recording dates 12/10/68, 16/10/68, 19/10/68, 18/11/68, and 10/12/68).

simple realisation. The dwindling number of protostructure forms with identical consonants in later stages, i.e. during later observation sessions, supports this explanation. Taking into account the three data sets presented in 9.2.1 above ( $C^1_x V_y C^2_x V_y$  as a result of reduplication or reverse reduplication, or  $C^1_x V C^2_x V$ ), they have the following two aspects in common, amongst other things: i) the most simple (or familiar) consonant in the target word is repeated, such as nasals, stops and labials, and ii) these "simple" consonants are realised in the place of a (sequence of) complex consonant(s).

In the light of these common factors, i.e. motivation (the realisation of a target) and realisation (use of basic CVCV structure that constitutes a realisation of a target), the usefulness of the distinctions as discussed in the literature is questioned. Following these distinctions, the three data sets can be described as follows:

- I completed reduplication
- II consonant harmony (with identical vowel realisations)  
or R→L (reverse) complete reduplication
- III consonant harmony or partial reduplication.

In this light, the distinctions do not appear to be useful; they certainly do not provide an insight into the background of the child's realisations.

From a theoretical point of view, it could be argued that, in the case of reduplication, the occurrence of a complex segment(s) in the target word that the child does not master yet gives rise to an empty segment slot(s) in his template which is CVCV(C), for instance. The more simple part of the target word is repeated so as to fill up this empty slot. Consonant harmony can be regarded as assimilation into an segment slot that is not specified because of non-contrastiveness (labial filling-in, free variation). However, the bottom-line is that the child realises a word as a simple protostructure,  $C_x V C_x V$ , because it contains something complex (the representation of which he has not mastered yet, or for which he does not have a contrast yet), giving rise to a blank in his representation that is filled up depending on the context. The different "processes" discussed can thus all be regarded as protostructure strategies which characterise the child's early phonological development.<sup>7</sup>

<sup>7</sup> Cf. MacNeilage and Davis (1990) where consonant harmony is considered to support 'the continuing importance of reduplication in early words' (1990:472).

So, the  $C_xVC_xV$  realisations enable the child to produce a target that, in its adult form, is too complex for him. The child distinguishes a familiar signal in a target, an acoustic aspect that he has mastered already. This familiar element and the basic CV syllable are the elements that are employed in the realisation of that target (cf. the realisation of *handkerchief* below). Complexity in this context also relates to the child's production itself. For instance, the child can master part of the target, but has to rely on the back-to-basics strategy when he attempts to expand his realisation to include more of and approach closer to the target structure. This is illustrated by the forms for *water*, presented below. (The contrast alveolar v. velar is established in #10.)

(8) a.	<i>handkerchief</i>	#4	[nænə nəni]	/hæŋkətʃɪf/	L
b.	<i>water</i>	#1	[ɑ:kə a.k <sup>h</sup> ə ɑ:k <sup>h</sup> ə]	/wɔtəʔ/	L
		#4	[wɔwə]		
		#6-7	[wɔ.tə wɔtə]		

Ultimately, the  $C_xVC_xV$  structures discussed here are the result of diverse strategies which create and make optimal use of the protostructure that has special status in the child's early phonological development.

#### 9.4 Dutch data

The following forms are taken from the data of the five children acquiring Dutch. They illustrate the "reduplication"/consonant harmony realisations in their output.

(9) a.	2	[tita]	<i>vliegtuig</i>	'aeroplane'	/vliχtœyχ/	#8
b.	4	[pæ'pɔ:]	<i>schapen</i>	'sheep'	/sχapə/	#6
c.	7	[papa]	<i>pinguin</i>	'penguin'	/pinguin/	#8
d.	8	[mɔmü]	<i>monkey</i>	'monkey', name	/mɔŋki/	#11
e.	8	[kaka]	<i>kaas</i>	'cheese'	/kas/	#8
f.	8	[pɔpɔ]	<i>pop</i>	'doll'	/pɔp/	#13
g.	9	[tita]	<i>bij zitten</i>	'to sit'	/zɪtən/	#12

The extent varies to which these children realise adult targets as  $C_xVC_xV$ ; Robin (2) has very few, Jarmo (8) has most (note that the tVtV realisations are left out of consideration here). Given that it is this last child whose output and early development of contrasts is characterised by a idiosyncratic CVCV structure, namely t-pattern, this is not unexpected (see 8. for a detailed discussion). For this child, the CVCV pattern is clearly a well-proven realisation strategy.



$C_xVC_xV$  forms occurred in the data of all five children, and the motivation seems to be similar to that of Jane and Lucy; this basic structure makes it possible for the child to realise a complex target.

### 9.5 Conclusion

The  $C_xVC_xV$  forms in the English child data from the Cruttenden corpus are concluded to be the result of strategies that are part of the same phenomena. Reduplication, i.e. the repetition of CV or C (or V) that the child has mastered and associated with the target word, and consonant harmony (either in free variation or in labial filling-in realisations) are the main strategies with regard to the data of Jane and Lucy. At the same time, the distinction between reduplication and consonant harmony appears unattainable, unless a developmental picture of the child's contrasts is taken into account. Namely, the phonological identity of the realised segments decides between the two different strategies, or phonological processes (cf. Ingram 1974a), whereas phonetically, that is, on basis of the output, this can not be determined. Overall, the distinction between reduplication and consonant harmony appears opaque rather insightful. It is concluded here that rather than separate phenomena, they are better regarded as protostructure strategies.

The data from the children learning Dutch (ChildPhon database) also gives evidence of strategies that create and use CVCV protostructure in the early realisations. However, the  $C_xVC_xV$  forms are not such a prominent feature.

10. Place development and protostructure strategies in English data

The data of two English children is discussed here in relation to the development of place of articulation (10.1), and the strategies that promote the basic CV structure in the child's output (10.2). This structure features prominently in the data studied of both English and Dutch children. The C<sub>x</sub>VC<sub>x</sub>V forms in the Cruttenden corpus are discussed with reference to the discussion regarding reduplication and consonant harmony in 9..

10.1 **Development of place of articulation**

The picture that emerges from the analysis of the Dutch acquisition data (ChildPhon) regarding place of articulation comprises the following stages:

- i) non-contrastive variability between the three main places of articulation.
- ii) labial place of articulation is mastered and consequently specified.
- iii) labial filling-in of non-specified place slots, i.e. velar and alveolar segments, and, at the same time, non-contrastive variability between alveolar and velar place of articulation.
- iv) all three places of articulation are specified: no free variation; the place realisation in the child's form is similar to that of the target word.

Similar observations can be made in the English data. Below examples from the data of Lucy (L) and Jane (J) of free variation and labial filling-in are presented.

(1) I

a.	<i>man</i>	[mæm]	/mæn/	L	#1
b.	<i>Ribena</i>	[bi:mʌ]	/rɑr'bi:nə/	L	#2
c.	<i>thumb</i>	[fʌm]	/θʌm/	L	#8
d.	<i>Daddy's <u>pen</u></i>	[pəm]	/pen/	J	#7
e.	<i>Jenny <u>can</u></i>	[kəm]	/kæn/	J	#8
f.	<i>gone</i>	[gəm]	/gən/	J	#6

II

a.	<i>two <u>bunny</u> rabbits</i>	[bʌmi]	/bʌni/	L	#16
b.	<i>another <u>one</u> again</i>	[wʌm]	/wʌn/	L	#10
c.	<i>button</i>	[bʌpə]	/bʌtn/	L	#6
d.	<i>not getting <u>them</u> tomorrow</i>	[bim]	/ðəm/	L	#19
e.	<i>pink <u>one</u> book</i>	[wʌm]	/wʌn/	L	#9
f.	<i>got <u>some</u></i>	[fʌm]	/sʌm/	J	#16
g.	<i><u>cup</u> of tea Lulu</i>	[pʌp]	/kʌp/	J	#13
h.	<i>bottom</i>	[bɒbɒm    bɒbɒn]	/bɒtəm/	J	#9,11
i.	<i>like <u>pudding</u></i>	[pʊpɪŋ]	/pʊdɪŋ/	J	#11

j.	<i>all broken</i>	[beɪbən]	/brəʊkən/	J	#13
<b>III</b>					
a.	<i>more <u>cup</u> of tea</i>	[tʌp]	/kʌp/	L	#8
b.	<i>doggy</i>	[gɒgi gəʊgi]	/dɒgi/	L	#1,3,5
c.	<i>dolly</i>	[gɒgi]	/dɒli/	L	#4
d.	<i>sick</i>	[kɪ]	/sɪk/	J	#10
e.	<i><u>cuddle</u> teddy boy</i>	[kʌku]	/kʌdl/	J	#13
f.	<i>cushion</i>	[kəkən]	/kʊʃən/	J	#9
g.	<i>cotton</i>	[kɒkən]	/kɒtn/	J	#4
h.	<i>table</i>	[kɑ]	/teɪbəl/	J	#3
i.	<i>sugar</i>	[tʊʔə]	/ʃʊgəʔ/	J	#9
j.	<i>sucker</i>	[sʌsə ʌtʌ]	/sʌkəʔ/	J	#11-13
k.	<i>Suki</i>	[su:si]	<i>name</i>	J	#8

When none of the three main places of articulation have stabilised, they are in free variation (non-contrastive variability) (J #1-6 stops, #1-11 nasals, #15 continuants; L #1-8 nasals, #14 continuants). (The evolution of oppositions in the phonological systems of Jane and Lucy is presented in 3., Figure 3.) Examples of free variation are given in Ia.-f. above. Labial realisation of a non-labial target is widespread in the early observation sessions of the two children, whether context-dependent (Ia.-d.), or context-free (*Jenny can* and *gone*, Ie.-f.).

For both children, labial is the first place to become stable, and thus specified (J #6 stops, #11 nasals, #15 liquids, #16 fricatives; L #1 stops, #8 nasals, #14 fricatives, #15 liquids). The labial specification gives rise to labial filling-in of an empty place slot, that is, of alveolar or velar targets. The requirement for this is the presence of a labial segment in the environment of the empty slot. Indeed, this is illustrated by the forms in IIa.-j.. With regard to the labial realisation of a non-labial target segment, the differentiation between labial filling-in and free variation forms is made on basis of the overall development of contrasts.

At the time when both alveolar and velar are not yet specified, free variation between those two places of articulation is also observed. Examples are given in IIIa.-k.. Note that in this period of the development of the child's phonological system, when labial is the only specified place of articulation, the two options for realisation (free alveolar/velar variation and labial filling-in), amongst others, are interchangeable. This is illustrated by Jane's realisation of *pudding*:

(2) a.	<i>pudding</i>	[pʊpɪŋ]	/pʊdɪŋ/	J	#10
b.	<i>like <u>pudding</u></i>	[pʊgɪŋ]	<i>idem</i>	J	#8

With regard to free variation, and alveolar and velar target consonants, there is an overwhelming bias in favour of a velar realisation of an alveolar target. The reverse case, an alveolar realisation of a velar target, is near-absent. Only *sugar*, *sucker* and *Suki* (IIIi.-k.) represent the free variation-realisation of velar as alveolar. These three forms seem to reflect the child's concentration on the realisation of alveolar fricatives, rather than the inability to produce velar stops (cf. the realisation of *water* discussed in 9.3).

The assimilation strength hierarchy that is proposed in Cruttenden (1978) is based on the data of Lucy, and it is not surprising that velar is assumed to be stronger than alveolar (i.e. apical). However, the forms presented in IIIa.-k. are all instances of free variation. The realisation of velar targets as alveolar, reflected in the Cruttenden hierarchy as velar>apical (see 9.2.2), is regarded as an idiosyncratic feature of, or preference regarding, the output of this child.

With regard to the overall place development attested in the data of the five Dutch children studied, the English data reflects a similar development (labial is the first specification, cross-category; [t/k] variation; and labial filling-in). However, the "reduplication" strategy, present in the data of both English children, masks the effect of the place development to some extent. As a consequence, the data is less transparent in expressing the acquisition of place as described above.

## 10.2 Protostructure strategies

The important role of the CV structure in the output of the two children during the early stages of their phonological acquisition has already become clear from the discussion on reduplication in 9.. In this section, different mechanisms are discussed that also result in a CV structure. In general, each child appears to have an idiosyncratic set of strategies that assist him in realising adult targets and that satisfy the protostructure.

### 10.2.1 Dummy consonants

The occurrence of [ʔ h] in the data of Lucy and Jane is very limited in comparison with the Dutch acquisition data. Certainly, there is no set of realisations in the child output that have an initial dummy consonant in the form of glottal stop or [h]. It can thus be concluded that this category of CVCV strategies is not represented in the Cruttenden data, and the data do not allow much to be said about the role of glottal stop and [h]. The few instances of glottal stop in the data are non-

initial and occur in the place of word-final plosives, i.e. glottal replacement (3a..-b.). Overall, these realisations do not appear to illustrate a strategy on the part of (one of) the two children.

(3) a.	<i>cot</i>	[kəʔ]	/kɒt/	L	#1
b.	<i>bike</i>	[baɪʔ]	/baɪk/	L	#8
c.	<i>gone <u>bike</u></i>	[baɪʔ]	<i>idem</i>	J	#8

Several instances in Jane's output present (potential) word-initial /h/ targets which are realised as vowel-initial forms (which could be a characteristic of the adult language the child actually heard):

(4) a.	<i>mummy buy <u>him</u></i>	[ɪm]	/hɪm/	J	#15
b.	<i>go see <u>him</u></i>	[ɪm]	<i>idem</i>	J	#16
c.	<i>daddy's nearly eaten <u>all his lunch</u></i>	[ɔl ə lʌn]	/ɔ:l hɪz lʌntʃ/	J	#20

This indicates some flexibility in the child's template in that it allows vowel-initial words in the output. (Note that it concerns sessions during the later period of the data observations.)

#### 10.2.2 Filling-in of non-specified segment slots

Non-specified segment slots, in the context of the child's early CV syllable concept, can occur in the place of a consonant cluster or a "difficult" segment (in a sense, this also includes the absence of a consonant in the case of a vowel-initial target word). At the time when a child has not yet fully mastered these kinds of targets, they present a (over-) complex situation to the child. However, in order to attain realisation, the initial consonant slot is realised through the filling-in of the initial consonant slot by means of the articulatory specification of (a) surrounding segment(s). This strategy is illustrated by the forms below.

(5) a.	<i>apple</i>	[pʰapʰa]	/æpəl/	L	#1
b.	<i>like some <u>apple</u></i>	[pæpu]	<i>idem</i>	L	#17
c.	<i>apple</i>	[ba:pʰu:]	<i>idem</i>	J	#4
d.	<i><u>all gone</u> now</i>	[gɒ gɒ]	/ɔ:l gɒn/	L	#10
e.	<i>all gone</i>	[gɒgɒn]	<i>idem</i>	J	#8,9
f.	<i>flower</i>	[pauə]	/flaʊəʔ/	L	#1
g.	<i>mummy's rice <u>crispies</u></i>	[pɪpɪz]	/krɪspɪz/	L	#10
h.	<i><u>drink</u> milk</i>	[gɪŋ]	/drɪŋk/	J	#11

Examples 5a.-e. concern vowel-initial targets. A pre-vocal segment slot that is part of the child's standard CV template in the early stages of (phonological) acquisition is provided with the

articulatory information of the word-medial consonant though spreading. Although not as widespread as in the data of some of the Dutch children, this strategy is also represented in the data from the Cruttenden database.

An interesting and isolated case presents itself in the realisation of *up* by Jane: the consonant and vowel are metathesised so as to produce a form that satisfies the basic CV structure.

(6) a.	<i>up</i>	[bä b <sub>Λ</sub> ba]	/Λp/	J	#4,8
b.	<i>up there</i>	[ba dεə b <sub>ü</sub> dεə]	/Λp ðεə/	J	#8,10
c.	<i>upstairs</i>	[ba dεə]	/Λp'steəz/	J	#10
d.	<i>get up</i>	[gɪ b <sub>ä</sub> ]	/get Λp/	J	#12

### 10.2.3 Partial realisation of clusters

Besides the filling-in strategy (10.2.2), clusters are also dealt with applying other strategies. In the Dutch data, the breaking-up and reduction of clusters were among these strategies. Examples representing this cluster breaking strategy are:

(7) a.	7	[bǝlumətɪs]	<i>bloemetjes</i>	'flowers', dim.	/bluməcəs/	#21
b.	7	[su'vɑ:n]	<i>zwaan</i>	'swan'	/zvan/	#16

Rather than breaking-up a cluster or filling-in its empty slot, in the English corpus, target clusters are partially realised or reduced. Two sets of data illustrate the partial realisation of clusters: i) the realisation of one of the consonants in the cluster (8Ia.-g.), and ii) the fusion of (place and manner) characteristics of the consonants in the cluster (or utterance) (IIa.-f.).

(8) I						
a.	<i>biscuit <u>please</u></i>	[pi:s]		/plɪ:z/	L	#8
b.	<i>baby's <u>pram</u></i>	[pæm]		/præm/	L	#8
c.	<i>another one's down (on) the <u>floor</u></i>	[fɔ]		/flɔ:ʔ/	L	#16
d.	<i>sleep</i>	[ʃi:p]		/sli:p/	L	#7
e.	<i>story</i>	[də:wi gə:wi]		/stɔ:ri/	J	#5
f.	<i>Jane's <u>scooter</u></i>	[kʊt <sub>Λ</sub> ]		/sku:tɔʔ/	J	#13
g.	<i><u>squirrel</u> is coming back</i>	[kɪru]		/skwɪrəl/	J	#15
II						
a.	<i>don't like <u>Smarties</u></i>	[fa:ti]		/smɑ:tɪs/	J	#16
b.	<i>Lulu won't touch my little <u>sweetie</u></i>	[fi:ti]		/swi:ti/	J	#18
c.	<i>swan</i>	[fɒm]		/swɒn/	J	#13
d.	<i>going my <u>swimming</u> baths</i>	[fɪmɪn]		/swɪmɪŋ/	J	#17
e.	<i>swimming</i>	[fɪmɪŋ fɪmɪn]		<i>idem</i>	L	#7,12
f.	<i>going to <u>sleep</u> in a minute</i>	[fi:p]		/sli:p/	J	#20

With regard to the labial quality of the fusion realisation of the initial clusters in *don't like Smarties*, *Lulu won't touch my little sweetie*, and *swan* (8IIa.-c.), this is present in the target cluster. The realisation of *going my swimming baths* and *swimming* (IIId.-e.), however, where a labial segment is part of the child's realisation (and target) outside the consonant cluster also point to the possibility of filling-in. Actually, in these cases, it is not clear whether the labial quality of the consonant in the child's form originates in the cluster or at the source of labial spreading. It is only in a form such as *going to sleep in a minute*, realised as [fi:p] (IIIf.), that the influence of the final labial consonant, in the form of filling-in of the initial labial segment, can be decisively concluded. More generally, these forms illustrate the reliance of the child on labial when faced with complexity in the early acquisition period.

10.2.4 Across-word interaction

In the output of both Lucy and Jane, the overall reliance on CV structure also becomes clear with regard to the realisation of target words that have a CVC or VC form. In their data, there are three main sets of realisations representing a (sub-) strategy on the part of the child to achieve a CVCV output. The different strategies are given below (i.-iii.), as well as examples to illustrate them (I-III, respectively):

- i. concatenation with preceding word-final consonant.
- ii. deletion of word-initial vowel.
- ii. creation of a word-final vowel.

(9) I			
a.	<i>get up</i>	[gɛdʌp]	/get ʌp/ L #8
b.	<i>fall off</i>	[fālɔf]	/fɔ:l ɒf/ L #8
c.	<i>bite it</i>	[baɪtɪt]	/baɪt ɪt/ L #9
d.	<i>ride it</i>	[raɪdɪt]	/raɪd ɪt/ L #8
e.	<i>Daddy get it</i>	[gedɪ]	/get ʌp/ J #9
II			
a.	<i>go away</i>	[gəʊ weɪ]	/gəʊ ə'weɪ/ L #16
b.	<i>another one penny</i>	[nʌdə]	/ə'nʌðə/ J #14
c.	<i>go away</i>	[gəʊ væ]	/gəʊ ə'weɪ/ J #13
d.	<i>biting my finger again</i>	[geɪn]	/ə'gən/ J #20
III			
a.	<i>oh dear!</i>	[dɪjə]	/dɪə/ L #4
b.	<i>book</i>	[bʊkæ]	/bʊk/ L #4
c.	<i>cake</i>	[keɪkɪ kɛki k <sup>h</sup> eɪkɪ]	/keɪk/ L #1,2,4



d.	<i>beer</i>	[bijə]	/bɪəː/	J	#8
e.	<i>cake</i>	[kɪki: kɛki]	/keɪk/	J	#3

In comparison with the relevant forms and sub-strategies in the data of the Dutch children studied (ChildPhon), where the scope of all four strategies analysed embraces two adjacent words (see 7.2.3), only one strategy in the Cruttenden data has an across-word scope. This strategy (i.) is also observed in the Dutch data, namely concatenation with the preceding word-final consonant.

### 10.3 Summary

With regard to place of articulation, the development observed in the data of Jane and Lucy is in agreement with the different stages of place development and specification concluded for the data of the five Dutch speaking/acquiring children studied (ChildPhon). In this context, labial filling-in, free variation and the [t/k] alternation were observed, as well as an overall reliance on labial in the earlier observation sessions. Both English children favoured velar realisations of alveolar targets. This is regarded here as an idiosyncratic feature in a free variation context.

Both the development of place of articulation and the protostructure strategies (discussed in relation to the Dutch data (7.)) are affected by the widespread occurrence of  $C_xVC_xV$  forms in the data of Jane and Lucy. Despite the masking of these phenomena, especially the place development, there seems to be an overall agreement between the English and Dutch acquisition data on these aspects.

Vowel-initial words did not appear to present the English children with a target that required a CV strategy, such as the realisation of a dummy consonant, in order to realise it. The child's template thus appears to be flexible in that it allowed VC forms. However, vowel-initial targets were realised with an initial consonant as part of the strategy to fill-in non-specified slots, for instance, "complex" initial consonant clusters. Initial clusters were also realised by means of fusion of features, or the realisation of one consonant of the cluster.

Overall the strategies observed in the English acquisition data are similar in motivation to those in the Dutch data. The actual form of the CV strategies is partially different. No conclusion can be drawn regarding the differences between the English and Dutch data on basis of the English acquisition data because the English children were growing up together, amongst other things. Generally, all strategies observed aimed at the realisation of a target by means of protostructure,

and the variations in solution illustrate the versatility of the child's approach to the realisation of targets that he has not fully mastered yet.

### III NOTATION AND PHONOLOGICAL ACQUISITION

In II, the acquisition data from the ChildPhon and Cruttenden databases is discussed on the basis of the phenomena observed (consonant harmony, dummy consonants, CV protostructure, etc.), and with regard to the development of the children's phonological system. This discussion is conducted in general terms. For instance, the evolution of the early phonological system in II3. is presented simply with reference to groups of segments, e.g. *nasal stops*, *continuants*. In this section, III, the focus is on phonological representation. In particular, the suitability of different notational models to represent the early stages of phonological development will be evaluated on the basis of the acquisition scenario concluded in II3.. The discussion here is by no means intended to present a complete overview of the history of the development of notation, nor to evaluate the notational frameworks discussed exhaustively. Rather, those aspects are mentioned that have direct relevance to the phonological development observed.

The models of phonological representation discussed are binary features, feature geometry, dependency phonology, radical CV phonology and articulatory phonology (including tube geometry) (2.-6., respectively). Before evaluating these individual models, a brief overview regarding segmental representation will be presented relating them in terms of their chronological development (1.). This overview discusses binary feature notation and feature geometry. The latter can be regarded as a mixed model (as far as most versions of the geometry tree is concerned), incorporating both binary and monovalent features. Monovalent features are briefly mentioned. However, a more detailed notational account is presented in 4. and 5., where dependency phonology and radical CV phonology, i.e. models based on unary components, are discussed and evaluated with regard to the acquisition process. Articulatory phonology presents a model that is quite different from most other phonological notations. It focuses on the relation between phonological and articulatory structure, and proposes the gesture as basic representational unit that is defined in terms of articulatory movement. This model, which was introduced with reference to acquisition, is discussed in 6..

The main aspects with reference to which these particular notational models of segmental phonology will be evaluated are the representation of manner classes, expression of (relative) sonority and of place features in the oral cavity. The development of these aspects is of main

importance during the early stages of phonological acquisition, as has been concluded on basis of the evolution of phonological development. With regard to place of articulation, a specific investigation into the adequacy of dependency phonology (labial and lingual components) and the articulator-based model of feature geometry (labial, coronal, dorsal) is conducted in 7., with direct reference to acquisition data.

# 1. Segmental representation

## 1.1 Phoneme v. feature

The great number of different sounds observed in the languages of the world can be traced back to combinations of a limited number of features, of which they are realisations. This insight into human phonology, namely that features rather than phonemes are ‘the ultimate constituents of phonological analysis’ is supported, amongst other things, by the disablement, change and acquisition of language (Clements 1985:225). The decomposition of speech sounds into sets of features is reflected in the notion of feature bundle or feature column, as adopted by Jakobson and the Prague School of linguistics, and later by the generative tradition (Clements and Hume 1995:246). According to the Jakobsonian school, the main function of features is to express the contrastiveness of phonemes, hence *distinctive features*.<sup>1</sup>

A feature bundle represents a segment and is ‘a simple list of binary-valued distinctive features’(McCarthy 1988:85). An example is the representation of the word *tee*:

(1)	/ t	i /
	- son	+ son
	+ cons	- cons
	- syll	+ syll
	+ cor	- cor
	+ ant	- ant
	- high	+ high
	- low	- low
	- back	- back
	- cont	+ cont
	- nas	- nas
	- lat	- lat
	etc.	etc.

Such single-column matrices, as used in the SPE (*Sound Pattern of English*) system proposed by Chomsky and Halle (1968), do not have internal organisation; ‘any two features characterising a phoneme are as closely (or as distantly) related as any two others’ (Clements 1985:225). The advantages of this kind of matrix are claimed to be the following (Clements and Hume 1995:246):

- (2) i. it is conceptually simple.
- ii. it is mathematically tractable, i.e. it has ‘a simple mathematical structure [that is] easily susceptible to analytical and computational manipulation’ (Clements 1985:225).
- iii. it imposes powerful constraints on the way features can be organised in representations.

<sup>1</sup> Cf. also Anderson, S.R. (1985:118, 135).



[ $\alpha$ back,  $\beta$ cor,  $\gamma$ ant] and the environment as [ $\alpha$ cor,  $\beta$ ant,  $\gamma$ back] in the rule given above (McCarthy 1988:86), results in a sound rule that is in no way formally more complex than the one given in (4). However, in phonetic terms, it represents a non-assimilatory rule which is less likely to occur and which is therefore expected to require a more elaborate expression. In terms of this type of rule, assimilation has no special status because it is expressed similarly to uncommon, or even non-observed, processes. Representations that employ Greek letter variables thus fail the componentiality assumption, which states that '[t]he representation of the internal structure of segments optimises the expression of phonological relationships ... that are (a) recurrent and (b) natural' (Anderson and Ewen 1987:8, see also 4.) (cf. below). Namely, more general rules are more simple (or as complex) than less general rules. On these grounds, linear rules can be said to be inadequate, and single column matrices to require modification.

Modification of the SPE notation of features has also been argued for on different grounds. Phonological features have been classified into taxonomic categories, which have also been claimed to have some kind of cognitive status (Clements and Hume 1995:248); sonority *v.* tonality features in Jakobson and Halle (1956), major class features and cavity features in Chomsky and Halle (1968), etc. Up to and including the formulation of SPE theory, however, these proposals to categorise features were not expressed in the actual feature representation. (See Clements and Hume (1995:248) for a more elaborate discussion.)

If we find that certain sets of features consistently behave as a unit with respect to certain types of rules of assimilation or sequencing, [there is] good reason to suppose that they constitute a unit in phonological representation, independently of the actual operation of the rules themselves (Clements 1985:226).

(For an early discussion of internal segment structure, see Lass 1976). Feature matrixes, as noted above, lack internal organisation, and any two features relate as closely to one another as any two other features in a matrix. Modification of the SPE notation in order to implement the findings that certain features group together takes the form of a hierarchical feature organisation (1.3), or gestural differentiation (4.).

Another argument against SPE-type feature matrices, besides the two problems associated with Greek letter variables and (the lack of) feature hierachisation, is found in the scope of features. In a matrix, any particular value of a feature describes one phoneme only. The scope of a feature is thus restricted to one segment. Studies into tone languages, on the other hand, have shown that a



single tone can extend over several syllables, requiring a one-to-many relation between tone and tone-bearing unit, respectively. Also, in a feature matrix, the phoneme described has one value only for a particular feature. Contour tones, i.e. rising and falling tones, however, are described as having two tones associated with one syllable, namely a low and a high tone (rising), or a high and a low tone (falling). Again, the way tones relate to tone-bearing units is not as uniform as the one-to-one relation expressed by SPE features for features and segments (Clements and Hume 1995:246-48). Studying sound phenomena such as complex segments (i.e. post- and pre-nasalised segments), nasal and vowel harmony, etc. has led phonologists to assume that similar relations as those discovered for tones in tone languages are appropriate for features in general and the description of sounds, albeit on a smaller scale. This has been discussed most influentially by Goldsmith (see 1.2).

## 1.2 Linear v. non-linear

Goldsmith (1976) presents autosegmental phonology that regards features as residing on separate tiers. Rather than positing a linear string of segments, two or more tiers are assumed that each consist of a string of segments. Autosegmental tiers are different planes or levels in phonological representation. Segments on different tiers differ with respect to the features for which they are specified. (As they reside on autosegmental tiers, the segments are referred to as autosegments.) Tiers are thus defined by the features that are specified on it. The segments on the different tiers are connected through association lines. These co-ordinate the tiers in representing simultaneity in time, phonetically speaking. The tiers themselves represent different sequences of gestures (articulatory) or distinct acoustic transitions (acoustically) (McCarthy 1988:86, Goldsmith 1990:8-11). For example,

The tonal tier ... represents the gestures that the larynx makes towards the tone of the word, and the non-tonal tier tier represents the gestures of the mouth. Unless we specify further, using association lines to indicate how the gestures of the larynx and the mouth match up, this two-tiered representation will not tell us which tone or tones are produced at the same time as each of the vowels are produced (1990:10).

With regard to segmental representation, the skeletal tier is of importance. The units represented on this tier are C and V, for consonant and vowel, respectively, and undifferentiated X. They are also called slots since 'they are the segments to which vowels and consonants must associate if they are to be realized' (Goldsmith 1990:48). These slots on the skeletal tier function as the anchor points for elements on other tiers, and are an indication of the character of associated

segments. The feature represented on the skeletal tier is  $[\pm\text{syllabic}]$ . Segments not specified on the skeletal tier are considered autosegments in the narrow sense.

To illustrate these basic concepts, prefixation in Luganda, a Bantu language spoken in Uganda, is discussed here in autosegmental terms (Goldsmith 1990:50-54). In Luganda, both vowels and consonants can be long as well as short. Every noun has a noun class prefix indicating one of the 21 classes. For instance, the class 1 prefix (singular) *mu-* and class 2 prefix (plural) *ba-* associate with the stems *kazi-* 'woman' and *ezi-* 'sweeper':

- (5) a. *mu kazi* 'woman'                      *ba kazi* 'women'  
       b. *mw eezi* 'sweeper'                      *b eezi* 'sweepers'

In the second example (5b.), the stem begins with a vowel. Because of this, i) prefix *mu-* is realised as *m*+glide, ii) the vowel in the prefix *ba* is deleted and iii) the following, initial vowel of the stem is lengthened. These changes can be transparently accounted for in an autosegmental representation.

- (6) a.    C   V       V   C   V                      b.    C   V       V   C   V  
           |   |       |   |   |                      |   |       |   |   |  
           m   u       e   z   i                      b   a       e   z   i
- ai.    C   V       V   C   V                      bi.    C   V       V   C   V  
           |   |       |   |   |                      |   |       |   |   |  
           m   u       e   z   i                      b   a       e   z   i
- aii.    C   V       V   C   V                      bii.    C   V       V   C   V  
           |   |       |   |   |                      |   |       |   |   |  
           m   u       e   z   i                      b   a       e   z   i
- mw eezi*       'sweeper'                      *b eezi*       'sweepers'

All vowels and consonants in the prefixes *mu-* and *ba-*, and in the stem *ezi* are short, and therefore associated with one slot on the skeletal tier, C or V. When two vowels are adjacent, the second vowel associates with the V-slot of the first and subsequently lengthens, as formulated in rule A., presented in (7a.) (see 6ai. and bi.). This process is referred to as compensatory lengthening. The first vowel is dissociated from the V-slot. It can either be reassociated with the preceding C-slot, according to rule B. (7b.), or it remains unassociated.

- (7) a. rule A.  $\begin{array}{c} \text{V} \\ \vdash \\ \alpha \end{array} \quad \cdot \cdot \cdot \quad \begin{array}{c} \text{V} \\ | \\ \beta \end{array}$       b. rule B.  $\begin{array}{c} \text{C} \\ | \\ \alpha \end{array} \quad \cdot \cdot \cdot \quad \begin{array}{c} \\ \\ [+ \text{high}] \end{array}$

In the case of an unassociated [+high] vowel, rule B applies and the vowel is reassociated with the preceding consonant. In this way, initial *m* (in 6a.ii.) as well as *u* associate with a single C-slot, where *u* is desyllabified, thus causing glide-formation. These segments are orthographically represented as *mw* and associated with a single C-slot. In the case of an unassociated [+low] vowel, rule B does not apply as, according to Goldsmith, '[t]here are no mid vowels that are in the appropriate position to see what would happen to them' [*sic*] (Goldsmith 1990:52). The vowel in the *ba-* prefix thus remains unassociated and is consequently not realised phonetically following the Linkage Condition presented below (1990:53).

(8) ***Linkage Condition***

A segment will not be phonetically realized if it is not linked to a position in the skeletal tier.

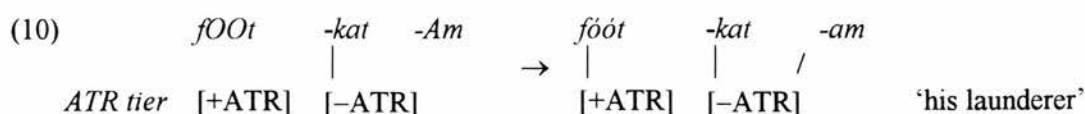
The processes of vowel lengthening, and glide-formation and vowel-deletion are shown to be closely related in the discussion of prefixation in Luganda. The changes in association between the skeletal slots, on the one hand, and the elements on the other tier, on the other hand, are responsible for the processes observed; the elements on the separate tiers have not changed. Association lines can thus express complex segments in autosegmental phonology.

Association lines and autosegments are also involved in the representation of the wider-than-one-segment scope of phonological features, in reflecting assimilation processes. For instance, nasal assimilation or harmony is regarded as the spreading of the feature [+nasal]. Similarly, [ATR], i.e. the feature Advanced Tongue Root or pharyngeal opening, is involved in harmony. This is illustrated by Wolof, a West Atlantic language (Kenstowicz 1994:347), in which the suffix *-kat* is consistently followed by [–ATR] suffixes. Crucial in the description of this process is the Line-Crossing Prohibition (McCarthy 1988:86):

(9) ***Line-Crossing Prohibition***

No association lines between the same two autosegmental tiers may cross.

[ATR] is specified on a separate tier, and roots will select a [+ATR] or [−ATR] specification in the lexicon. For instance, *fOOt* is linked with [+ATR], resulting in *fóót* ‘launder’ (where capitals indicate lexical representations that are not yet linked to an autosegment). (Wolof has [+ATR] vowels, /i u é ó ë/, and [−ATR] vowels, /e o a/.) The agentive suffix *-kat* is linked with a [−ATR] specification on the ATR-tier. Because of this specification, spreading of [+ATR] from *fóót* to the suffix *-Am* in the example below is blocked, and the line crossing prohibition limits spreading. For Wolof, it is also assumed that only one autosegment is associated with a vowel, so [+ATR] does not spread to *-kat* either.



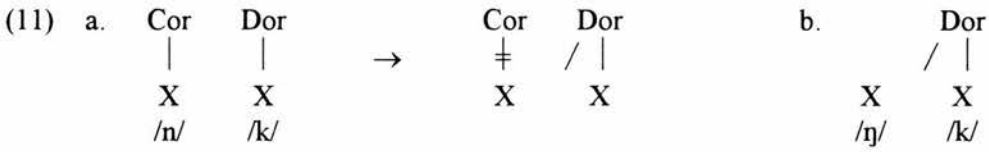
[−ATR] can spread, however, from *-kat* to *-Am*, as the former also has a specification on the ATR tier, resulting in *-am*. This is the mechanism behind the consistent appearance of [−ATR] suffixes following *-kat*. These suffixes can not receive an [ATR] specification from the root because the spreading from the root is blocked by *-kat* according to the Line-Crossing Prohibition (9) (Kenstowicz 1994:349, 351-53).

So, assimilation processes can be accounted for by means of (dis)association of autosegments; it is the spreading of the assimilating feature over a larger domain. The “natural” status of assimilation over disassimilation can thus be expressed, and non-linear phonology is in this respect more successful than a linear notation (see discussion on Greek letter variables, 1.1). The ability to express one-to-many and many-to-one relations within an autosegmental notation makes it possible to manipulate the scope of features; something that also proved problematic in SPE (see 1.1). The notational advantages of autosegmental phonology have been incorporated in the theory of feature geometry that addresses the grouping of features with regard to their phonological behaviour (see 1.3), amongst other things.

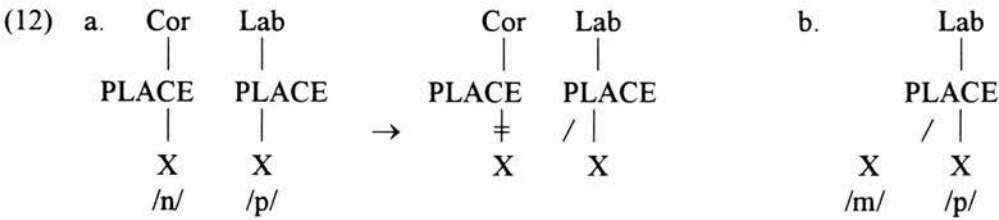
### 1.3 Hierarchical groupings

Feature geometry notation is based on the observation that (groups of) features display autonomy with regard to their segmental behaviour in phonological processes. This is illustrated by the spreading of the place of articulation features onto the preceding alveolar /n/ in *Kent*. This can be

expressed in an autosegmental representation as the spreading of the velar place feature dorsal onto the preceding consonant, and subsequent delinking of the alveolar feature of the /n/, the coronal component (for a discussion on monovalent features, see 1.4).



From this representation (11b.), it becomes clear that the segments in the /ŋk/ sequence share the same place of articulation. A similar case in point is the spreading of the labial place of articulation feature in *in Paris*. To capture this similarity, namely that it is place of articulation that can spread, in this example to the preceding /n/, the feature PLACE has been proposed. In saying that PLACE spreads, three otherwise different phenomena (labial, alveolar and velar spreading) can be captured. Also, the three places of articulation are thus claimed to be features of the same type and to each represent a value of the overall PLACE feature. This is represented as follows, for the labial assimilation in *Paris* (Spencer 1996:151-53):

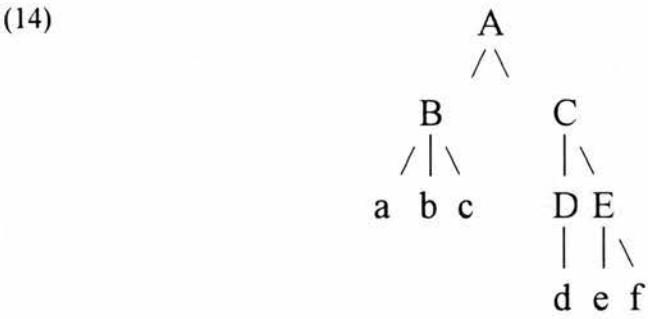


In a feature geometry representation, the place features are captured as a natural class by positing a hierarchically higher, and therefore dominating, node, PLACE. The separate places of articulation are sub-features of this node, and branch from it (see Figure 14).

Another example of the autonomous behaviour of (a set of) features is provided by the Icelandic preaspiration rule. The preaspiration process involves laryngeal and supralaryngeal features, the former reflecting the state of the glottis and the latter the state of the oro-nasal articulators in terms of place and manner of articulation. In Icelandic, the geminates /p<sup>h</sup>p<sup>h</sup>, t<sup>h</sup>t<sup>h</sup>, k<sup>h</sup>k<sup>h</sup>/ are realised as [hp, ht, hk], respectively. Assuming two separate tiers for the laryngeal and supralaryngeal features, 'preaspiration is most insightfully described in terms of a rule deleting the set of



branches emanate from A, the root node, which corresponds to the speech sound itself (Clements and Hume 1995:249-50):



In a feature geometry representation, the organisation of phonological features is thus as follows (1995:51):

- (15) i. feature values are arrayed on separate tiers, where they may enter into non-linear relations with one another;
- ii. features are at the same time organized into hierarchical arrays, in which each constituent may function as a single unit in phonological rules.

Furthermore, it is assumed that *phonological rules perform single operations only*. The form and the functioning of phonological rules is restricted by a powerful principle; ‘only feature sets which form constituents [i.e. are dominated by a single node] may function together in phonological rules’ (1995:250). This is claimed to express a strong claim as the number of nodes in a feature geometry is small in comparison with the logical combinations of the features in that geometry. Different types of assimilation can now be represented straightforwardly; spreading of a terminal node, a constituent node or a root node represent the assimilation of a single feature, partial and total assimilation, respectively (Clements 1985:231) .

*Feature organisation is universally determined*. Both across languages and across the levels of derivation (from underlying lexical form to surface structure), the organisation of the feature geometry is assumed to be uniform. This makes cross-linguistic predictions possible. With regard to derivation, the feature geometry is regarded as a template defining well-formedness (Clements and Hume 1995:249-51).

Each level in the feature geometry is assumed to be motivated by its own principles of analysis: ‘the justification for the categories and principles proposed for any linguistic level must be



supported entirely by evidence pertaining to that level' (Clements 1985:230). According to the early discussion of feature geometry in Clements (1985), the justification of the phonological features themselves must be sought in the nature of phonological and phonetic processes, and not 'from *a priori* considerations of vocal tract anatomy ...' (1985:230).

The model of feature geometry has been influential in the field of phonological notation, and many competing proposals have been presented with regard to the actual organisation of the geometry tree (for a critical discussion, see Kenstowicz (1994), and Clements and Hume (1995)). The resulting, overall picture of segmental representation in terms of feature geometry lacks consensus (Kenstowicz 1994:451). This appears to be especially unfavourable for the feature geometry notation given the strong claim of universality of segmental structure. In 3., specific models of feature geometry will be discussed in relation to their merits for the description of the acquisition process.

#### 1.4 Binary v. monovalent

Distinctive features are used to describe phonological segments and to characterise natural classes (see 1.1). With regard to any particular feature, the assumption in SPE, amongst others, is that a sound is either characterised by that feature value or it is not. There is thus a binary opposition between two classes of sound; one class can be represented by the positive value of the feature value pair: [+F], the other can be represented by its negative value: [-F] (Spencer 1996:107). The assumption that features are two-valued is fundamental to the segmental representation in SPE (Chomsky and Halle 1968:295):

Since the only question of interest here [i.e. discussion on phonetic and phonological representation] is whether or not a given item belongs to the category in question, it is natural to represent this information by means of a binary notation ...'.

This claim does not acknowledge the different types of opposition, formulated by the Prague School. On the assumption that a phonemic system 'is not just an inventory of contrasting segment classes, but a system of oppositions' (Lass 1984:41, cf. Anderson, S.R. 1985:289), different contrastive relations between members of a phonological system are described. These include, amongst others (Trubetzkoy 1969:75, cf. Lass 1984:45-46):

- (16) *privative oppositions*      One member of an opposition is characterised by the presence, and the other by the absence of some feature or *mark*; usually a feature that can be regarded as "added on" to another

	articulation. The opposition member that is characterised by the presence of the mark is called "marked". For example, nasal v. non-nasal, voiced v. non-voiced.
<i>gradual oppositions</i>	The individual members of this opposition are characterised in terms of various degrees or gradations of the same property. For example, vowel height.
<i>equipollent oppositions</i>	The members of an equipollent opposition are logically equivalent, they are neither considered as two degrees of a property nor as the absence or presence of a property, and they can not be defined in terms of any minimal criteria (Lass 1984:46). In other words, 'they both have a role to play in phonological processing' (Harris and Lindsey 1995:37). For example, /f/ v. /k/, /p/ v. /t/ in English.

In SPE, the binary notation specifies both members of the assumed oppositions; features are thus regarded as uniformly part of an equipollent opposition. This view has been the subject of criticism from advocates of post-SPE notational frameworks. This group includes monovalent notational models, e.g. dependency phonology, radical CV phonology (see 4. and 5.), as well as "mixed" theories. An example of a mixed theory is given in Sagey (1986), which presents a feature geometry hierarchy with unary class nodes and binary terminal nodes (see 3., and, in particular, 3.1). The objections overall concern two aspects: restrictiveness and the description of phonological processes (1.4.1 and 1.4.2, respectively).

#### 1.4.1 *Restrictiveness*

Both van der Hulst (1989) in his discussion of radical CV phonology and Harris and Lindsey (1995) adopt the criterion of restrictiveness to evaluate the valency of the units for segmental description. They agree that '[u]nary primes are to be preferred over binary features because they lead to a more constrained theory' (van der Hulst 1989:256). Monovalent features, e.g. [nasal], predict that it is only the presence of a feature that is relevant in the description of phonological processes, and thus that there is an asymmetry in the behaviour of phonological features. In autosegmental terms, the "relevant" feature can either link or delink, its presence will block spreading, whereas its absence has an empty and, with regard to spreading, a transparent slot as a consequence. The presence of the other member in the effectively privative opposition is assumed not to be required in representation

Binary feature theory makes the claim that all oppositions are equipollent and thus that the two members of an opposition have equal status. However, asymmetrical behaviour of phonological

features has been incorporated in binary feature representation as well, by means of markedness theory and underspecification. SPE introduces markedness theory; both feature value pairs of a feature are indicated to be “marked” (*m*) or “unmarked” (*u*). An equipollent opposition thus has a marked and an unmarked member. Note, however, that for some equipollent oppositions, one feature value pair is not more (or less) marked than the other. Note also that the value of the marked member can be context-dependent (see below). ‘The complexity of the lexical item [depends] on the number of features that are not left unmarked in a matrix representation; each such marked entry will distinguish the item from the “neutral”, simplest lexical item’ (Chomsky and Halle 1968:403). Markedness is assigned by means of marking conventions.<sup>6</sup> Radical underspecification is in accordance with this practice, in that it does not specify unmarked feature values underlyingly; only the marked value is lexically present. In this respect, a binary feature approach incorporating radical underspecification or markedness theory is comparable with unary features, it is claimed (see remarks above). However, the nature of the default rules that fill in the underspecified values, or the marking conventions, can change on a language-specific basis, thus overturning the “universally marked” value of a feature. Also, at the point that the unmarked value is filled in, both values can be active in phonological processes, and their status does no longer reflect the asymmetry of the different values in their phonological behaviour. Radical underspecification theory is therefore claimed to be non-falsifiable (van der Hulst 1989:255).

Monovalent features are inherently underspecified for the unmarked value (in the Trubetzkoyan sense), which does not partake in phonological processes, and markedness is non-changeable. Markedness is thus incorporated in monovalent segmental representation without the need for external devices. On these grounds, binary feature theory, as well as “mixed” theories, such as some feature geometry proposals, are rejected as weaker theories (Harris and Lindsey 1995:37-39, van der Hulst 1989:255-57).

#### 1.4.2 *Phonological processes*

Binary features are also criticised in the context of expressing phonological processes (in favour of a unary notation) (Anderson and Durand 1986:23):

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<sup>6</sup> This mechanism has been criticised by Anderson and Ewen (1987:16), amongst others, as the indication of markedness involves an un insightful, ‘added on ad hoc’ means of expressing markedness, and preference is given by them to an intrinsic means of deriving markedness from the representation as such. For a rejection of (SPE) markedness in phonological representation, see Lass (1975, 1980).

The main, and apparently the only, reason put forward by Chomsky & Halle for adopting binary feature in *lexical representations* in that ‘the natural way of indicating whether or not an item belongs to a particular category is by means of binary features’ (1968:297). ... Given that Chomsky & Halle appear in SPE to have jettisoned most of the Jakobsonian motivation for binarity (e.g. its use in decoding speech, its biological roots, its psychological salience, ...), the conciseness of binarity has to be weighed against other considerations. In particular, many phonological regularities do not involve simple bifurcation but are hierarchical.

One of the phonological phenomena that has been presented in the literature to illustrate that monovalent features, rather than a binary SPE representation, provide a (more) insightful description is, amongst others, the process of *i*-umlaut in Old English.

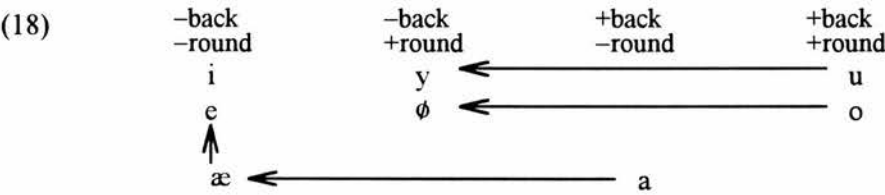
*I*-umlaut involves the raising of low front vowels to mid front and the fronting of back vowels under influence of the *i* or *j* in the following syllable, namely (Lass and Anderson 1975:117):

- (17) a. 

<i>u</i>	→	<i>y</i>
<i>o</i>	→	∅
<i>a</i>	→	<i>æ</i>
<i>æ</i>	→	<i>e</i>
- b. examples

<i>mann</i>	‘man’	<i>menn</i>	‘men’
<i>hāl</i>	‘whole’	<i>hælan</i>	‘heal’
<i>dōm</i>	‘judgement’	<i>dēman</i>	‘judge’

(for both long and short vowels, except *æ*, which is not affected by *i*-umlaut). A representation of these changes in terms of binary features would give the following picture, where *i*-umlaut is reflected by two sub-processes: *fronting* [+back] → [−back] and *raising* [+low] → [−low] (Anderson and Durand 1986:33, Figure 40):



The characterisation of vowels in unary components, for instance, as proposed in dependency phonology, presents a more unified account of *i*-umlaut. (For a discussion of the dependency phonology notation, see 4..) Articulatory components, either in combination or in isolation, represent the vowels; |i| “frontness”, |u| “roundness” and |a| “lowness”. A monovalent description of *i*-umlaut employing these components looks as follows (1986:33, Figure 41):

(19)

i	{ i }	y	{ i,u }	←	{ u }	u
e	{ i;a }	∅	{ i,u;a }	←	{ u;a }	o
↑						
æ	{ a;i }					
		↖	a	{ a }		

As becomes clear from the monovalent representation of the *i*-umlaut changes, this process involves a ‘minimal increase in the preponderance of |i|’ (1986:34). This notation thus provides the insight that *i*-umlaut involves the addition of the |i| component that characterises the triggers /i/ and /j/ (1986:32-34). (For a critique on dependency phonology concerning the restrictiveness of markedness predictions, see Allan and Bauer 1991).)

## 2. Binary features and acquisition

### 2.1 Binary features

Pre-SPE, Jakobson and associates presented a set of binary features in *Fundamentals of language* (1956) and *Preliminaries to speech analysis* (1967). These features represent 'the limited number of characteristics ... [that] are utilized in the various languages of the world for semantic discrimination' (Jakobson, Fant and Halle 1967:16). A set of features, relevant to the discussion here, is given in (1), together with a short (non-acoustical) description of (a member of contrast of) the feature value pair (Jakobson and Halle 1956:29-32).<sup>1</sup>

(1)1.	<i>vocalic/non-vocalic</i>	primary or only excitation at the glottis together with a free passages through the vocal tract.
2.	<i>consonantal/non-consonantal</i>	presence v. absence of an obstruction in the vocal tract.
3.	<i>compact/diffuse</i>	forward-flanged v. backward flanged; there is a difference in the relation between the volume of the resonance chamber in front of the narrowest stricture and behind this stricture.
4.	<i>nasal/oral(non-nasalised)</i>	mouth resonator supplemented by the nose cavity v. the exclusion of the nasal resonator.
5.	<i>discontinuous/continuant</i>	rapid turning on or off of source either through a rapid closure and/or opening of the vocal tract, or through taps.
6.	<i>grave/acute</i>	peripheral v. medial oral stricture

In terms of the Jakobsonian features, the early stages of phonological acquisition as discussed on the basis of the ChildPhon and Cruttenden data (II3.) would be underlyingly represented as in (2i.-iv.):<sup>2</sup>

(2)	i.	<i>oral stop</i> [+cons, -nasal]	<i>nasal stop</i> [+cons, +nasal]	
	ii.	<i>oral stop</i> [+cons, -nasal, -cont]	<i>nasal stop</i> [+cons, +nasal, -cont]	<i>continuant</i> [+cons, (-nasal), +cont]
	iii.	<i>oral stop</i> [+cons, -nasal, -cont]	<i>nasal stop</i> [+cons, +nasal, -cont]	<i>continuant</i> [+cons, (-nasal), +cont]
				<i>labial stop</i> !

<sup>1</sup> Other features are: tense/lax, voiced/voiceless, strident/mellow, checked/unchecked, flat/plain, sharp/plain (Jakobson and Halle 1956:29-32).

<sup>2</sup> For Jakobson's account of the acquisition of phonological contrasts, e.g. Jakobson (1968), see the discussion in II3..

iv.	<i>oral stop</i>	<i>nasal stop</i>	<i>fricative</i>	<i>liquid</i>
	[+cons, -nasal, -cont]	[+cons, +nasal, -cont]	[+cons, (-nasal), +cont, -vocalic]	[+cons, (-nasal), (+cont), +vocalic]

In a scenario that is based on the assumption that underlying representation is minimal, the characterisation of the nasal stop is different from its contrastive counterpart in (2i.) with regard to its [+nasal] specification (natural class characterisation of nasals: [+consonantal, -vocalic, -continuant, +nasal]). Binary features are considered to be equipollent (see 1.4). On the basis of this status, it is thus expected that the [+nasal] specification only makes sense when [-nasal] is used underlyingly as well to describe the non-nasal natural class. Hence, the oral stop in the first categorial opposition (2i.) is characterised as [+cons, -nasal]. Regarding the [-nasal] specification for the continuant, fricative and liquid entities, this is redundant on basis of their [+cont] feature value pair ([+cont] → [-nasal]) (redundant specifications are given between parentheses). Similarly, [+voc] → [+cont].

With regard to the specification of the labial stop, its required specification within a Jakobsonian acquisition scenario is not clear. The place of articulation labial is characterised by the features [+grave, -compact]. To specify the entity labial stop as [+grave] would also cover the class of velar segments ([+grave, +compact]). To specify it as [-compact] would also cover the class of alveolar segments ([-grave, -compact]). It therefore does not seem possible to identify the labial entity on basis of one binary feature that uniquely distinguishes it from all other entities.

As far as the acquisition of manner of articulation is concerned (2), the acquisition scenario in terms of binary Jakobsonian features represents the contrastive entities appropriately. However, it does not provide an insight into the acquisition process as such. As binary feature matrices are not structured internally, they do not make any predictions regarding the order of acquisition or the relative “importance” of features in establishing the underlying contrasts, either inter- or intra-segmentally. Moreover, the scenario does not express anything about the characteristics that underlie the process as such, in terms of a unified dimension, such as sonority (see II3.).



With regard to the feature set proposed in Chomsky and Halle's *The sound pattern of English* (SPE), the features required for the initial contrasts of the acquisition process are similar to those in the Jakobsonian scenario ([consonantal, continuant, vocalic]), with the exception of the place features and the characterisation of nasal. The nasal stop entity is specified for [+sonorant], rather than for [+nasal] (see above). This does refer to sonority as the crucial underlying dimension of the acquisition of the manner classes. However, [sonorant] is either present or absent in underlying segments. This does not reflect the importance and relevance of sonority as a scalar feature in the acquisition process. The characterisation of the labial stop entity proves equally opaque in SPE terms.

Also, the [+vocalic] specification for liquids is not self-evidently correct (*idem* [+continuant]). The contrastive entity liquid in the acquisition scenario comprises the following phones, amongst others: [w v l r j] (see II3.). In terms of Chomsky and Halle (1968:303), this group entails two different natural classes, namely liquids and glides (l) (i.e. [w j]), which are specified differently for both [consonantal] and [vocalic] (positive feature values for the liquids, and negative values for the glides). So, in this respect, the contrastive entity in (2iv.) can not be characterised as a natural class.

## 2.1 Markedness in acquisition

As observed, SPE incorporates the notion of markedness (see 1.4.1.) as Chomsky and Halle (1968:402) identify

the need for an extension of the theory to accommodate the effects of the intrinsic content of features, to distinguish "expected or "natural" cases of rules and symbol configurations from others which are unexpected and unnatural.

The expression of markedness is by means of the indication of "marked" (*m*) or "unmarked" (*u*) for each feature value pair. 'The complexity of [a] lexical item will depend on the number of features that are not left unmarked in its matrix representation' (1968:403). The *u* and *m* coefficients are assigned to the lexical matrix on the basis of the marking conventions proposed in SPE (see below).

Next, the acquisition scenario is considered from the perspective of markedness in the context of SPE, to assess whether the markedness apparatus can provide or contribute to an insightful acquisition account. The entities of the manner of articulation contrasts are represented in (3) together with an indication of their markedness.

(3)	[-vocalic]							
i.	<b>oral stop</b>		<b>nasal stop</b>					
	[+consonantal]	U	[+consonantal]	U				
	[-nasal]	U	[+nasal]	M				
ii.	<b>oral stop</b>		<b>nasal stop</b>		<b>continuant</b>			
	[+consonantal]	U	[+consonantal]	U	[+consonantal]	U		
	[-nasal]	U	[+nasal]	M	([-nasal])	U		
	[-continuant]	U	[-continuant]	U	[+continuant]	M		
(iii.)								
iv.	<b>oral stop</b>		<b>nasal stop</b>		<b>fricative</b>		<b>liquid</b>	
	[+consonantal]	U	[+consonantal]	U	[+consonantal]	U	[+consonantal]	M
	[-nasal]	U	[+nasal]	M	([-nasal])	U	([-nasal])	U
	[-continuant]	U	[-continuant]	U	[+continuant]	M	([+continuant])	U
					[-vocalic]	U	[+vocalic]	M

*Redundancy rules*  
[+continuant] → [-nasal]  
[+vocalic] → [+continuant]

The characterisation of the first contrast, oral stop v. nasal stop, includes the secondary aperture feature [nasal], rather than the major class feature [sonorant] (Table 1, 1968:303), because the marking conventions refer to [nasal] in first instance (cf. [-nas] → [-son] (XIV; 1968:405)). The contrast is between a unmarked v. a marked feature value pair (3i.) on the basis of the following marking conventions:

- (4) a.

$$[u \text{ cons}] \rightarrow \left\{ \begin{array}{l} [+cons] / \left\{ \begin{array}{l} + \\ [+voc] \\ [-cons] \end{array} \right\} - \\ [-cons] / \left\{ \begin{array}{l} - \\ [-voc] \\ [+voc] \end{array} \right\} \end{array} \right\}$$

(II; 1968:404).
- b.

$$[u \text{ nasal}] \rightarrow [-nasal]$$

(XIII; 1968:405).

As becomes clear from (4a.), the specification for [vocalic] is a prerequisite of the feature characterisation of the first contrast and its markedness evaluation. [-vocalic] is thus assumed to be specified before (6i.) with reference to the contrast consonant v. vowel, or [-vocalic] v. [+vocalic] (6).

The second contrast in (3) introduces the continuant entity. The resulting representation for all three contrasting entities is presented in (3ii.). The feature value pair between parentheses is redundant on the basis of the redundancy rules in (3). The newly acquired segment has also one marked feature value pair; continuant consonants are marked for the feature [continuant] ([*u*cont] → [-cont], the context-free part of XXIV; 1968:406). So, acquisition thus involves the addition of another segment with one “mark”, and can not be concluded to proceed from the unmarked to the marked on the basis of this (contrast’s) characterisation.

The fourth contrast, fricative *v.* liquid, involves the specification of the feature [vocalic]. Fricatives are non-vocalic (Table 1, 1968:303), which is an unmarked feature value pair on the basis of the [+consonantal] specification. Fricatives are marked for [continuant] (Table 12, 1968:412). As for the liquid characterisation, note the discussion above regarding the description of the liquid entity in SPE terms (2.1). However, accepting the [+consonantal, +vocalic] characterisation for the moment, [+vocalic] is marked on the basis of the [+consonantal] specification, and *vice versa*. This results in two marked feature value pairs. Concerning the [+continuant] characterisation of the liquid entity, this is unmarked ([*u*cont] → [+cont], XXXIV; 1968:407).

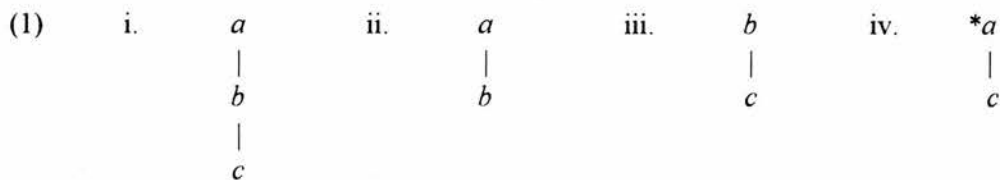
From the above discussion, it can be concluded that the markedness conventions in SPE are not overtly helpful for explanatory acquisition purposes. In a general sense, unmarked segments are acquired before marked ones. However, as becomes clear from the scenario in (6), this does not appear to offer a consistent guideline for the child as the number of marked feature value pairs is not truly gradually cumulative. Anyway, how the child is to have knowledge of the marking conventions without assuming complete innately given representation naturally is not clear. More generally, the characterisation of the non-fricative continuant class is unclear.

### 3. Feature geometry and acquisition

Feature geometry is a notational model that is grounded on the autonomous behaviour of (groups of) features, amongst other things. The representation of segments takes the form of a (wild) tree that expresses the hierarchical relations between features. This structure is assumed to be universal (see 1.3). From a strictly feature geometry perspective, the tree is innate (or at least its main nodes, only requiring acquisition of terminal nodes), and the process of acquisition does not contribute to the geometry representation. However, the cognitive approach adopted here assumes that the child has an innate ability to acquire phonological structure, and only starts off with innate attention biases rather than with (adult) structure (see 11.-2.).

On the basis of the assumptions that the number of contrasts in the child's system increases in the course of this phonological acquisition, and that more contrasts necessitate more nodes in a feature geometry, representation is expected here to proceed from less to more structure. With regard to the addition of nodes in the feature geometry, various options are available *a priori*. Namely, the possibilities are addition of nodes at the lower end of geometry branches, addition under the root node, and insertion into existing geometry branches, and a combination of two or all of these options. Secondly, the basic hypothesis regarding phonological representation is that a notational model should be able to represent both child and adult language in a similar way. It is thus assumed that what is considered valid for feature geometry representations in general is valid for a "child geometry".

One of the basic claims regarding feature geometry concerns universality - 'feature organization is universally determined' (Clements and Hume 1995:250). With regard to the addition of nodes in the feature geometry, the insertion of nodes between a subordinate and a superordinate node, i.e. branch intermediate, could give rise to inherently different geometries. Namely, branches with a different hierarchical structure of nodes imply different licensing conditions. For example, in the feature geometry branch in (1i.), *a* licences *b* which licences *c*. This is in agreement with (ii.) and (iii.). In (iv.), which is the geometry branch prior to the acquisition and branch intermediate insertion of *b*, however, *c* is licensed by *a* (rather than by *b*). Note intermediate insertion is thus rejected as feature geometry and node licensing therein are claimed to be universal.



In this light, the addition of nodes to the geometry tree during the acquisition process can take place either immediately under the root node, or at the bottom of the tree. Another “design characteristic” of feature geometry is that the presence of a dependent node entails the presence of a dominating node (McCarthy 1988:98). Combined with the observation that larger generalisations are stabilised before smaller in terms of natural classes (e.g. stop *v.* continuant before lateral *v.* central alveolar liquid), this points to the addition of nodes at the lower end of geometry branches.

Universality of feature geometry is thus ensured whereby the different stages of acquisition differ in representation with regard to the amount of structure, i.e. number of nodes. Most importantly, the structure that has been established is identical to the comparable part of the tree as proposed in the context of the description of adult language

On basis of the discussion above, acquisition is assumed to proceed from root to terminal nodes. The main aspects with reference to which particular feature geometry models will be evaluated are the manner classes, and place features in the oral cavity. More precisely, the initial stages of the evolution of the phonological system, repeated below, will be the touchstone for the assessment of the geometries discussed here. (For a discussion of the early development of the phonological system, see II3..)

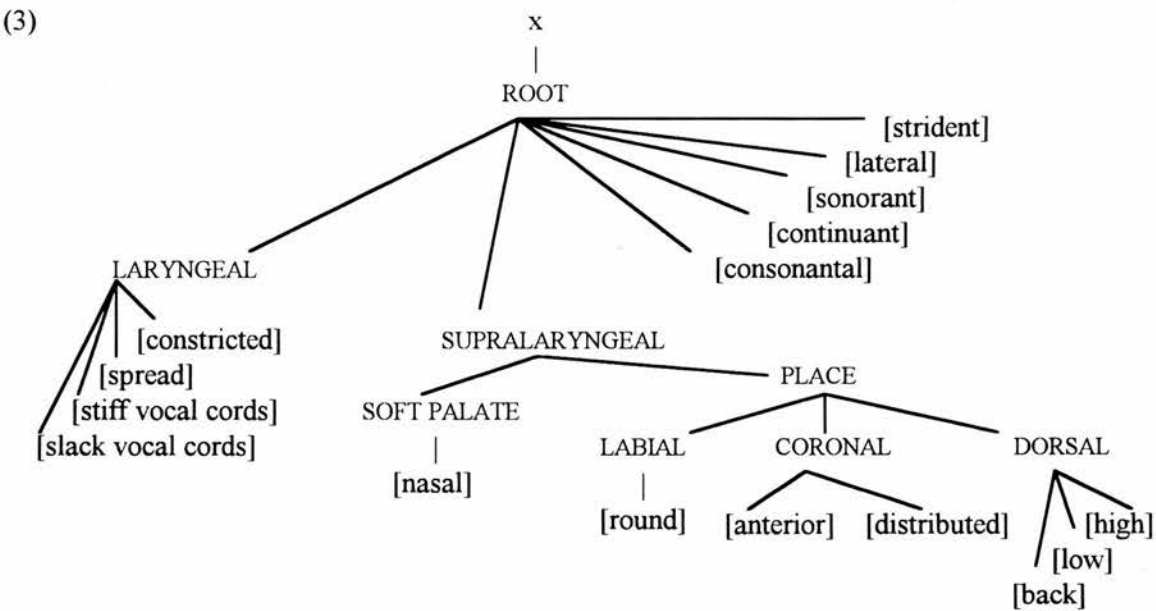
- |     |      |             |    |            |
|-----|------|-------------|----|------------|
| (2) | i.   | oral stop   | v. | nasal stop |
|     | ii.  | stop        | v. | continuant |
|     | iii. | labial stop | v. | stop       |

The feature geometry proposals that are discussed here, with emphasis on those aspects that are relevant to the acquisition scenario, are Sagey (1986, 1988), Clements (1985) and Rice (1992).<sup>1</sup>

<sup>1</sup> For a discussion and the motivation of (parts of) the various geometries see den Dikken and van der Hulst (1988), Kenstowicz (1994), and Clements and Hume (1995).

### 3.1 Sagey (1986, 1988)

The feature geometry proposed in Sagey (1986) is based on both phonetic and physiological observations (den Dikken and van der Hulst 1988:13), and is presented in (3). The features [strident], [lateral], [sonorant], [continuant], and [consonantal] are attached to the root node, as well as the class nodes Laryngeal and Supralaryngeal. The latter node dominates the Soft Palate and the Place node that branches into Labial, Coronal and Dorsal and their respective dependent features<sup>2</sup> (1988:14 after Sagey 1986). Note that class nodes are unary whilst terminal nodes are binary.



With regard to the first contrast established, oral stop *v.* nasal stop, to express this contrast concerning nasality in terms of the feature geometry in Sagey (1986), the manner features that are attached directly under that root node do not suffice. The opposition oral *v.* nasal stop thus requires a more elaborate notation. To represent nasal stop with [+nasal] does not appear to be possible here, because this entails two intermediate nodes, namely Soft Palate and Supralaryngeal (see 4ib.). Given that there are two contrastive entities in the system (besides vowel *v.* consonant), these two constituent nodes can not be motivated in terms of 'sets of features [that] consistently behave as a unit' (Clements 1985:226). This appears to be problematic for the nasal specification

<sup>2</sup> Note that PLACE also has the dependent node TONGUE ROOT - [ATR], similar to Sagey (1988) (III3., Figure 5).

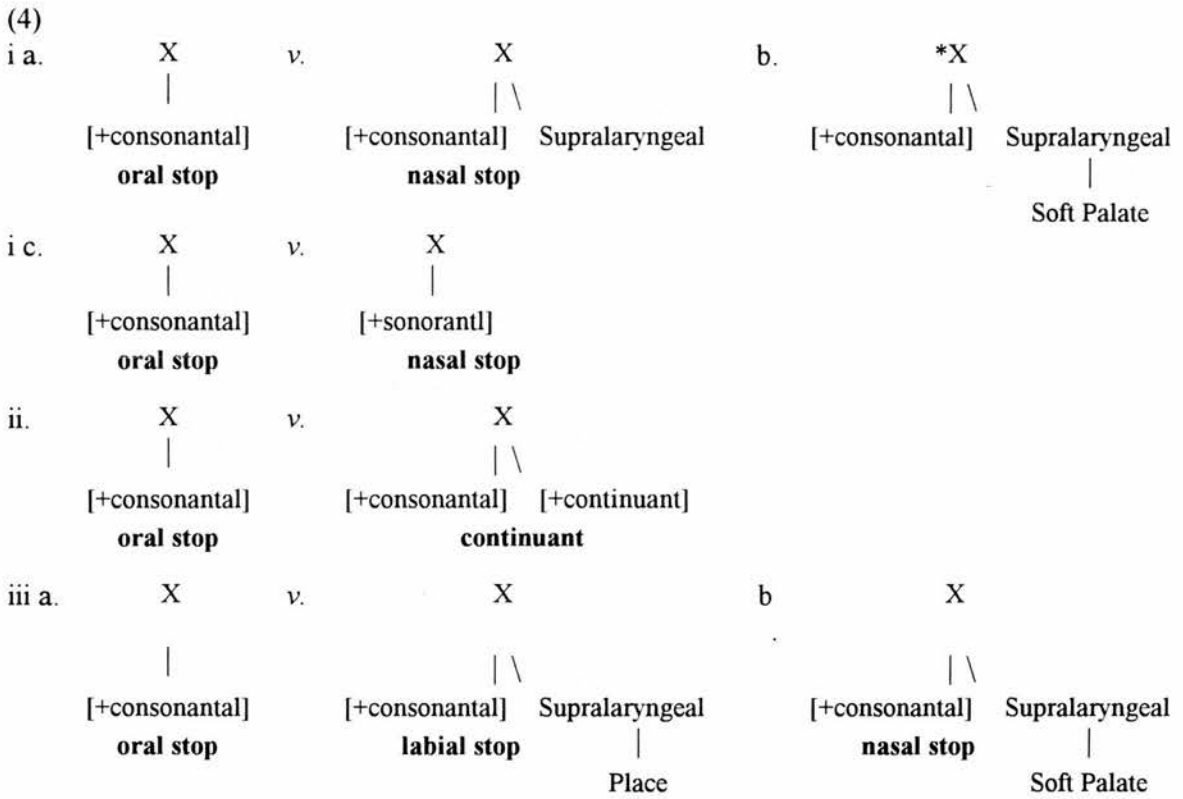
generally. Namely, a similar objection has been pointed out in den Dikken and van der Hulst (1988): Soft Palate ‘dominates only the feature [nasal], so that no empirical distinction exists between spreading the soft palate node or just the feature [nasal]’ (1988:16). A representation of the nasal stop in the first consonantal contrast should thus include [+consonantal] and Supralaryngeal, as given in (4ia.).

The absence of the observation during the early stages of phonological acquisition that ‘features ... regularly function together as a unit in phonological rules’ (Clements and Hume 1995:249) denies the necessity for a constituency node as such, as illustrated for Soft Palate above. This in turn leads to the formulation of a *monotonicity principle* as presented in Rice and Avery (1995) (see II4.2.2).

The minimal specification approach in the Rice and Avery (1995) proposal concerning phonological acquisition entails an unmarked and minimal starting point of segmental specification, and monotonic expansion, i.e. ‘addition of structure proceeds a single step at a time’ (1995:35). Apart from being an expression of their view on the acquisition process of phonology, the monotonicity requirement is also enforced by the choice of feature framework in their proposal. As a consequence of the adoption of feature geometry to represent early phonological acquisition and the subsequent monotonicity principle, powerful predictions are made with regard to the order in which the contrasts or segments are acquired. The predictions generated by their model, however, are not in agreement with the data observations based on the ChildPhon and Cruttenden data, and the discussion of this proposal is not concluded in favour of feature geometrical representation (see II4.2.2).

With regard to the representation of the early acquisition scenario in terms of feature geometrical notation, note that the opposition represented in (4ia.), oral stop v. nasal stop, is assumed to be contrastive in terms of relative sonority (II3.). The representation in (4ia.) does not express that the relevant parameter on which the opposition is based is sonority. Alternatively, the nasal stop entity can be characterised by [+sonorant] (5ic.). This, however, does not express the relativity of the degree of sonority, which appears to be essential to the acquisition process. It merely expresses that nasal stop is sonorant.

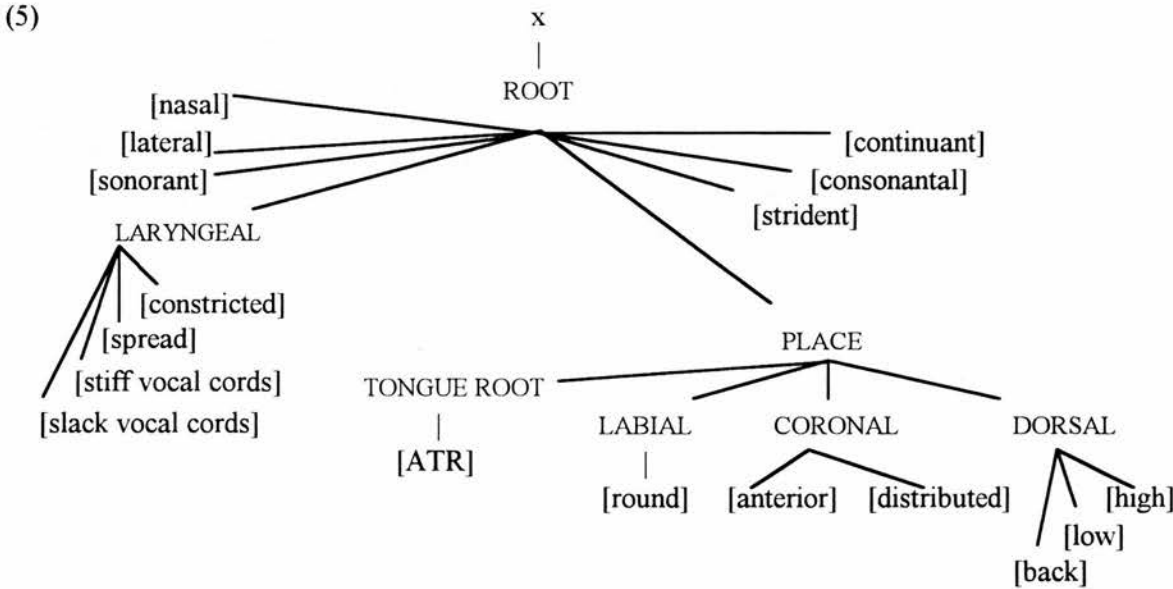




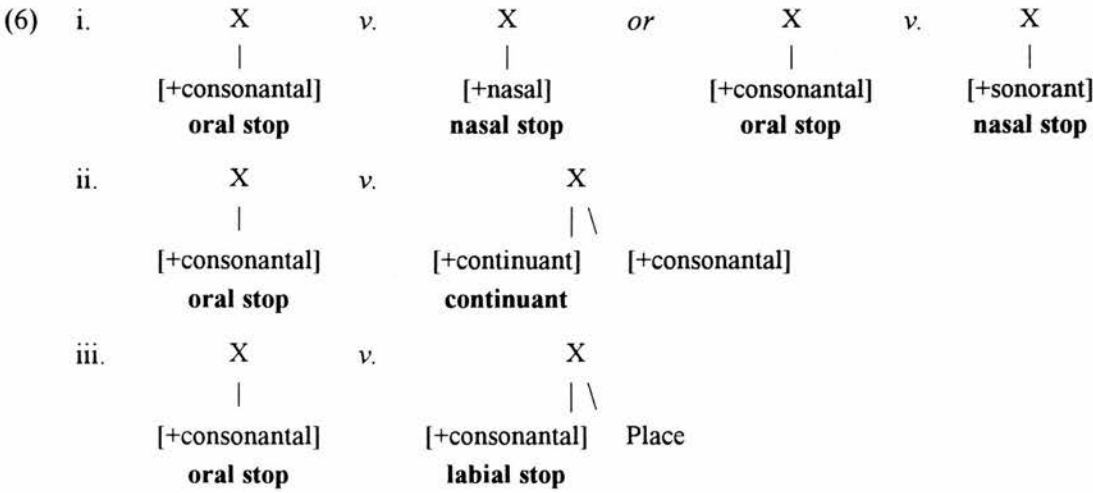
The second opposition, stop v. continuant, can be represented directly under the root node: [+consonantal] v. [+consonantal, +continuant] (4ii.). The third opposition, labial stop v. stop, enforces a more substantial elaboration of the representation (iii a.). Firstly, the labial quality is expressed by the sequence X-Supralaryngeal-Place. The Labial node is not yet specified as there is no opposition under the place node. As a consequence of the specification of Place, the representation for the nasal stop in (ia.) requires adjustment. With the introduction of the labial entity in the system, the Supralaryngeal node now dominates the Place node for the labial stop, and spreading the Supralaryngeal node entails spreading the Place node. This is undesirable if it concerns the spreading of nasality only. The representation for the nasal stop is accordingly expanded to X-Supralaryngeal-Soft Palate (iii b.).

The spreading of labial is now expressed by spreading the Place node that is dependent on Supralaryngeal. The label Place in this context is opaque and not informative with respect to the order of acquisition of place of articulation. Moreover, a different order of the places of articulation would not entail a different representation of the acquisition process.

In a later version of Sagey's geometry (Sagey 1988), the expression of nasality is also posited directly under the root node. In fact, all manner features are grouped individually, immediately dominated by the root node. Besides these feature nodes, two constituent nodes, Place and Laryngeal, are also attached at that hierarchical level, as presented below (Sagey 1988:170).



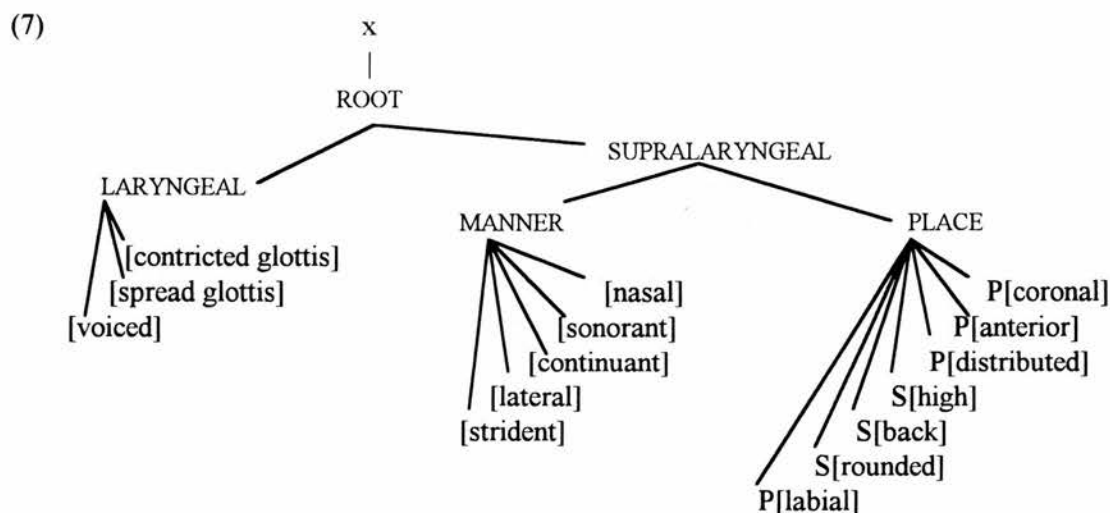
The representation of the early phonological contrasts in the acquisition of phonology, in terms of Sagey (1988), is in terms of features directly under the root node:



In (6iii.), Place represents labiality in the contrast labial stop *v.* stop. The representation X-Place-Labial is rejected on similar grounds as discussed above, namely the enforced monotonicity principle. The “manner contrasts” represent the contrasts between oral and nasal stop, and between stop and continuant. Both oppositions are assumed to be motivated by the differences in sonority between the contrasting entities. In the case of nasality in (6i.), this can be indicated by [+sonorant] rather than by [+nasal]. However, the overall observation that sonority, as a scalar feature, underlies the initial contrasts is not transparently expressed by the features proposed in Sagey (1988) either.<sup>3</sup>

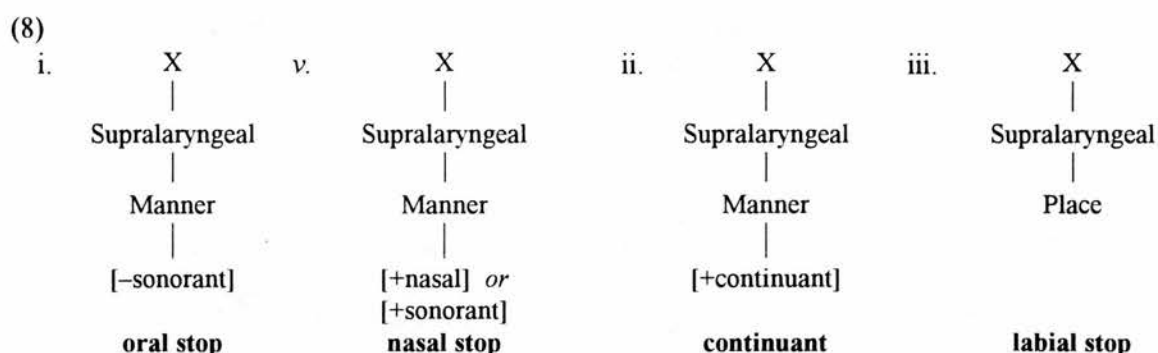
### 3.2 Clements (1985)

Similar to the arrangement of the manner features in Sagey (1988), Clements (1985) also places the manner features directly under one node in the feature geometry. In this model, however, there is a.) a separate Manner node, and b.) this node is located under Supralaryngeal, constituting the sister node of the Place node. The geometry in Clements (1985) is presented in (7) (Clements 1985:248 and den Dikken and van der Hulst 1988:13). (Sagey (1986/1990:19) also assumes (S)[low] under Place in this tree and [consonantal] under Manner.)



<sup>3</sup> Note that with regard to the motivation to adapt the hierarchy of features, den Dikken and van der Hulst (1988:18) claim that ‘the manner features are “moved around” in the feature tree without a lot of specific motivation’. Also, the “improvements” of the feature geometry models generally are based on “new” phonological processes, often found in different languages, and rarely discuss the evidence that is presented as motivation for previous models, let alone refute that evidence. This state of affairs does not appear to go well with the universality claim and quality of feature geometries in general (see III.3).

The initial stages of phonological development according to this model are expressed as follows:



Here too, the constituent nodes Supralaryngeal and/or Manner do not appear to be justifiable in terms of the criterion that the recurrent behaviour of a set of features as a unit constitutes a constituent node (Clements 1985). Unlike the representation in Sagey (1986) (see 3.2), the violation of the monotonicity principle here can not be solved by representing a dominating node only (namely, Supralaryngeal rather than Soft Palate or [nasal]). This is because representational difference is required for the oral and nasal stop, and the representations of these entities only diverge under the Manner node. The Supralaryngeal and Manner nodes in (8i.) and (ii.) can not be motivated in terms of a set of features behaving autonomously. In the context of the initial contrasts in the child's phonological system and its limited number of contrasts, (8i.-iii.) do not make sense.

With regard to sonority, underlying the contrasts in (8i.-iii.), the feature [sonorant] is part of the specification for the contrast oral stop v. nasal stop. However, it involves a binary rather than a scalar feature. Also, the observation that continuant (8ii.) is more sonorant than oral and nasal stops and less sonorant than a vowel is not indicated. Again, manner features do not transparently express the criterion that underlies the acquisition process.

When comparing the feature geometry in Sagey (1986, 1988) and Clements (1985), from the point of view of acquisition, it seems that the position of [sonorant], [nasal] and [continuant] directly under the root node is preferable. Placement of these features under a node lower down in the feature hierarchy leads to a substantial violation of the monotonicity principle, thus rendering the representation of initial contrasts invalid according to the feature geometry motivation of nodes

proper. Phonological acquisition thus provides support for the view expressed in Kenstowicz (1994) (cf. den Dikken and van der Hulst 1988:18-19):

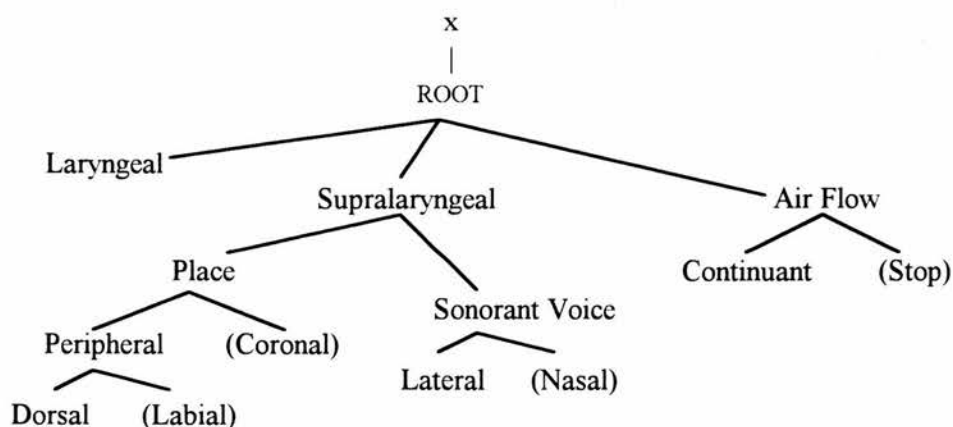
Placing [ $\pm$ consonantal] and [ $\pm$ sonorant] at the root of the feature tree expresses the intuition that higher-level features are the more basic categories of contrast ... [ $\pm$ consonantal] and [ $\pm$ sonorant] are major determinants of the sonority-driven syllabification routine that imposes the initial and most basic prosodic structure over the string of phonemes (Kenstowicz 1994:453).

### 3.3 Structural sonority - Rice (1992)

From the discussions in 3.1-2, it has become clear that the expression of sonority, which is assumed to underlie the contrasts in early phonological acquisition, is opaque in feature geometry. In the geometry models considered here, it is represented by means of binary manner features. Rice (1992) presents a notational model that is based on the principles of feature geometry and focuses on the representation of sonority in particular.

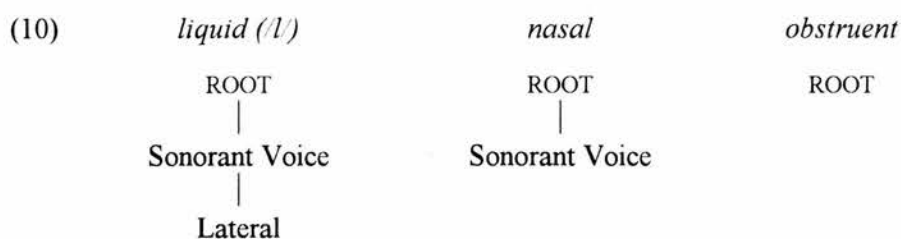
The feature geometry proposed in Rice (1992) is claimed to offer the possibility of deriving the sonority relations between consonants within a cluster. More generally, it is claimed that '[i]nspection of the structure of a segment ... gives information about ... phonological patterning' (1992:64). In this geometry, the feature [sonorant] is replaced by the Sonorant Voice node which is grouped with Place under the Supralaryngeal node, as indicated in (9) below (1992:62).

(9)



In Rice (1992), segments are specified by means of monovalent features, and underlying representations are not specified for unmarked content nodes, where the status of unmarkedness is determined by phonological processes, system inventories and acquisition evidence (1992:64). In

the feature geometry in (9), unmarked values are given between parentheses. (See Rice (1992) for a motivation of the individual feature's (un)markedness status.) The specification of a segment in terms of this geometry provides an indication of the relative sonority of that segment, which is relevant to the syllabification of consonant clusters. Relative sonority is structurally derivable from the specification under the Sonorant Voice node.<sup>4</sup> '[T]he less SV structure present in the segment, or the less complex the segment is in terms of SV structure, the less sonorant it is' (1992:65-66). The representations of liquid /l/, nasals and obstruents in terms of Sonorant Voice and its dependent nodes are given in (10) (1992:65).



The absence of the SV node in the specification of obstruents indicates its non-sonorous character. Nasals have more SV structure than obstruents and less than laterals, which corresponds to the position of this natural class on the sonority scale in relation to laterals and obstruents.

In accordance with the assumption made in Rice (1992:92) that 'segments that occur early in the acquisition process [are] structurally less complex', the representation of the three consonant classes above assigns more structure to nasals and liquids as these classes are introduced in the system later than obstruents. Similarly, the natural class of vowels is expected to be represented by a relatively simple representation as it is relevant at the onset of speech, when the opposition consonant v. vowel is established in the child's system. At the same time, with regard to sonority, vowels are positioned at the opposite end of the sonority scale from obstruents. On this basis, vowels are expected to have the most complex segmental representation. These stipulations of the amount of structure that is required for vowels, regarding order of acquisition and sonority, respectively, are not reconcilable; vowels can not be the most complex and the least complex segments in the same acquisition scenario (see also Heijkoop 1993). The proposal of Rice (1992)

<sup>4</sup> The SV node is also included in the notational framework adopted in Rice and Avery's (1995) acquisition proposal (see II4.2.2).

(or comparable articles by Rice and Avery) does not deal with the segmental representation of vowels, unfortunately.

### 3.4 Conclusion

The first contrasts that are established in the process of phonological acquisition (II3.) are regarded as the basis for the assessment of the models of feature geometry. The notational models discussed here are Sagey (1986, 1988), Clements (1985) and Rice (1992) (3.1-3).

Sonority is an important underlying notion characterising the early stages of the evolution of the phonological system as becomes clear from the child data studied. Its expression in segmental representation is thus relevant to the evaluation of a notational model in relation to acquisition. Overall, the expression of sonority in the geometry models studied is opaque. Manner features describe contrasts based on relative sonority in terms of nasality and/or continuity. The models in Sagey (1986, 1988) and Clements (1985) employ the binary feature [sonorant] (3.1-2). This, however, does not characterise the natural classes of segments on the basis of their position on the sonority scale. In the case of Rice (1992), the feature geometry is designed to express the relative degree of sonority of different segments in terms of amount of segmental structure, i.e. number of nodes. In the context of the acquisition of phonological structure, however, this model gives rise to unreconcilable stipulations (vowels are represented by little structure because they are a contrastive entity early in the acquisition process, and vowels have most structure because they are the most sonorant segments) (3.3).

More generally, the feature geometry notation is forced to adhere to the monotonicity principle with regard to acquisition of segmental geometrical structure (explicitly formulated in Rice and Avery (1995)). This is a consequence of the way the nodes or constituents in a feature geometry need to be motivated, namely with reference to the consistent behaviour of the (set of) features involved as a unit (Clements 1985). This proves problematic, for instance, where several (hierarchically related) nodes are included in the representation of a segment when there is only one consonantal contrast valid in the phonological system of the child (Clements 1985). Also as a consequence of the monotonicity principle, the characterisation of labial as the first place feature to be established is Place (Sagey 1988), which is not meaningful in the acquisition context. Also, the acquisition of the class node Place, a superordinate and non-binary node, seems to be too unspecific as it can represent any order of place acquisition. The definition of Place (superordinate



node in adult language, and the representation of labial in child language prior to the three-way place contrast) is thus not uniform during the different stages of language acquisition in a wider sense. A similar point can be made for the Supralaryngeal specification to describe nasality (Sagey 1986) (3.1).

The acquisition process contributes to the evaluation of feature geometrical notation, in the sense that it points to the positioning of the main manner of articulation features directly under the root node (see 3.2). Namely, this would avoid violation of the monotonicity principle, and does not require the motivation of (intermediate) constituent nodes (cf. Clements 1985).

*A priori*, feature geometry in combination with the monotonicity principle offers a powerful means of description for acquisition; it makes clear statements/predictions about the order of acquisition (cf. Rice and Avery 1995, II4.2.2). However, the actual features or node labels used appear to be not sufficiently relevant to the early acquisition process of phonology and the phenomena observed therein.

Here, the feature geometry tree presented in Keyser and Stevens (1994) that is explicitly based on articulatory and acoustic considerations might seem to offer a solution. However, it encounters similar monotonicity problems to the geometries discussed. For instance, the anatomical lay-out of the tree includes a Lingual node, sister node of Lips, under a Supranasal node. (See 4.4 for an account of the development of place of articulation by means of a lingual and a labial component.) However, the Lingual and Lips nodes can not be specified “directly” as they are not placed immediately under the root node. So, the feature dependency structure is concluded to be unfavourable to the description to early phonological acquisition under a nativist/constructivist approach to language (see 8. on structural dependency).

## 4. Dependency phonology and acquisition

### 4.1 **Model**

The theory of phonological description presented in Anderson and Ewen (1987), dependency phonology,<sup>1</sup> starts off from the following basis (1987:8):

#### (1) *Natural recurrence assumption*

- a. Classes of phonological segments are not random.
- b. Phonological classes and the regularities into which they enter have a phonetic basis.

#### *Componentiality assumption*

The representation of the internal structure of segments optimises the expression of phonological relationships ('classes', 'regularities') that are a) recurrent, and b) natural.

In dependency phonology, segment-internal representation is characteristically multi-gestural. This reflects the sub-groupings of features that are apparent from their behaviour in phonological processes. The representation of phonological structure in terms of gestures thus satisfies one aspect of the *recurrent* requirement of the componentiality assumption (1).

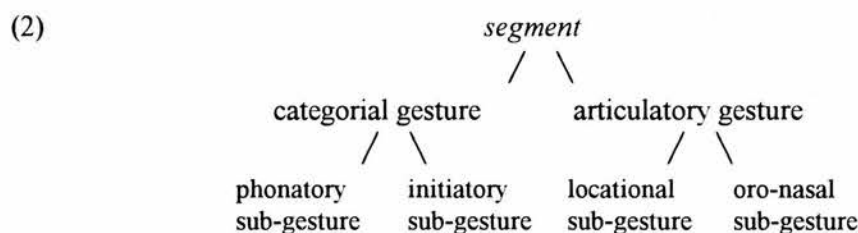
The incorporation of sub-gestures deals with one of the arguments against, and is a reaction to, the SPE-type feature matrices and their lack of internal organisation (see 1.1). Although different categories of features were acknowledged in and before SPE, they were not formally represented (cf. Anderson and Durand 1986:19-23).<sup>2</sup> Autosegmental phonology introduces separate tiers for features to exist and be specified on, thus introducing a slight degree of feature grouping (in comparison to feature geometry) (see 1.3). Also, it makes it possible to represent the scope of features more adequately than in SPE notation (see 1.2). With respect to autosegmental tiers, Anderson and Ewen (1987:36) state that these 'are established with reference to particular phonological phenomena, rather than on general grounds; that is, it is not clear just which (sets of) features can potentially form distinct tiers'. The presence of particular tiers is language and/or system dependent. This is different from the gestures posited in dependency phonology; the proposed nature and organisation of the (sub-)gestures therein are assumed to be universally valid.

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<sup>1</sup> Publications leading up to the model proposed in Anderson and Ewen (1987) are Anderson and Jones (1974, 1977), Anderson and Ewen (1980) and Ewen (1980). Collections of articles on dependency phonology are Durand (1986) and Anderson and Durand (1987).

<sup>2</sup> Feature geometry notation can be regarded as a direct reaction to this flaw in the SPE notation (see III1.3 and III3.).

Anderson and Ewen (1987) envisage segmental representation to take the form as given in (2): two gestures that each contain two sub-gestures (1987:148-49).<sup>3</sup> Their claim is that ‘phonological rules and processes may have as their domain just one of these gestures’ (1987:141). This is illustrated by the lenition process  $/t/ \rightarrow /s/ \rightarrow /h/ \rightarrow \emptyset$ , for instance, that is discussed below (Figure 3).



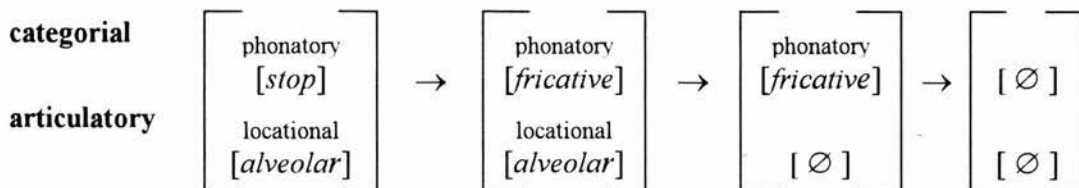
With regard to the contents of the sub-gestures in the proposed structure (2) (from left to right), these compare to “manner”, “glottal state”, “place”, and “nasality” (for a more detailed discussion, see below).

The first stage of the lenition process  $/t/ \rightarrow /s/ \rightarrow /h/ \rightarrow \emptyset$ , i.e.  $/t/ \rightarrow /s/$ , reflects a change in manner of articulation from stop to fricative, and therefore involves a change in the phonatory sub-gesture. The subsequent stage,  $/s/ \rightarrow /h/$ , involves a complete loss of place of articulation ( $/h/$  is considered to lack any place specification supralaryngeally), and can be represented by the deletion of the articulatory gesture, in this case, the locational sub-gesture.<sup>4</sup> The last stage of lenition to  $\emptyset$  is subsequently represented by deletion of the categorial gesture (1987:37-39, 175). Every separate process of this lenition sequence, recurrent in the histories of languages, can thus be regarded as taking place entirely in the domain of either the articulatory gesture or the categorial gesture. This is schematically represented in (3).

<sup>3</sup> The tonological gesture is not represented here (see Anderson and Ewen 1987:270-73). As tone is not relevant to the discussion of the process of phonological acquisition here, and it concerns an inherently suprasegmental phenomenon (1987:150), this gesture will be left out of consideration.

<sup>4</sup>  $/h/$  is regarded as a glottal fricative that lacks an oral matrix. In the same way that  $/h/$  is considered the reduction fricative,  $/ʔ/$  is considered the reduction stop (Lass 1984:179 after Lass 1976; Anderson and Ewen 1987:37-9). The change  $/s/ \rightarrow /h/$  can be regarded as deoralisation. (See II.6..)

(3)



The representational contents of the dependency phonology sub-gestures are discussed by Anderson and Ewen (1987; chapters 4-6) in the context of phonological processes from a range of languages. The properties that are assumed to be present within each sub-gesture are presented in the abstract matrix in (4) which indicates 'particular groups of features forming recurrent domains for phonological processes' (1987:149-50). The actual segmental components inhabiting each gesture will be discussed in 4.2 and 4.3.

(4)

<u>categorial gesture</u>	$  \begin{bmatrix} \begin{bmatrix} \text{consonantality} \\ \text{voice} \\ \text{continuity} \\ \text{sonorance} \end{bmatrix} \\ \begin{bmatrix} \text{glottal stricture} \\ \text{glottalicness} \\ \text{velar suction} \end{bmatrix} \end{bmatrix}  $	<i>phonatory sub-gesture</i>  <i>initiator sub-gesture</i>
<u>articulatory gesture</u>	$  \begin{bmatrix} \begin{bmatrix} \text{place} \\ \text{height} \\ \text{rounding} \\ \text{backness} \end{bmatrix} \\ [\text{nasality}] \end{bmatrix}  $	<i>locational sub-gesture</i> <i>oro-nasal sub-gesture</i>

Another aspect of dependency notation that directly relates to the componentiality assumption (1), beside the basic gestural division, is the encoding of naturalness;

a theory of segment structure should permit recurrent regularities to be expressed more simply than non-natural, irregular and sporadic groupings and relationships, i.e. ones which do not show natural recurrence (1987:9).

In Anderson and Ewen (1987), monovalent components are favoured over binary or scalar features; they argue that the last types of features do not represent phonological processes appropriately with regard to the reflection of markedness and naturalness (1987:11-28) (For the

motivation and nature of unary features, see the discussion in 1.4.) The effectiveness of monovalent features in a dependency representation is illustrated, for example, in relation to the characterisation of “manner” features (see 4.2).

#### 4.2 Manner of articulation - categorial gesture

Syllable structure reflects the hierarchical relation between the different types of segments, namely in the position in which these manner types occur in the syllable. This is represented as follows in Hooper (1976) in terms of binary features (Anderson and Ewen 1987:144):

(5)	+ cons – son	+ cons – cont + son	+ cons + cont + son	– cons + cont + son – syll	– cons + cont + son + syll
	<i>obstruents</i>	<i>nasals</i>	<i>liquids</i>	<i>glides</i>	<i>vowels</i>

The placements of segments in the syllable is thus mainly represented by the interaction of three features, [consonantal, sonorant, continuant]. Rather than adopting a description that refers to three different phonological dimensions,<sup>5</sup> Anderson and Ewen (1987) give preference to a unitary scale expressing the segment-type hierarchy. This scale is characterised by vocalicness, on one extreme, and consonantality, on the other, in accordance with the basic differentiation of segment types as proposed in Jakobson, Fant and Halle (1967:18-19), amongst others (see 1.2). Phonemes possessing the vocalic feature have ‘a single periodic (“voice”) source whose onset is not abrupt’. In articulatory terms, ‘[v]owels have no obstructive barrier along the median line of the mouth cavity, whereas consonants have a barrier sufficient to produce either complete occlusion or a turbulent noise source’, which affects the spectrum by the presence of zeros (1967:19-20).

To represent the vocalic-consonantal scale, two dependency components are adopted in the phonatory sub-gesture; |V| can be defined as ‘relatively periodic’ energy, and |C| is a component of ‘periodic energy reduction’ (Anderson and Ewen 1987:151). The realisations of the |V| and |C| components (at the two extremes of the scale) are vowels and voiceless plosives, respectively. The scale reflects the proportion of |V| and therefore the relative degree of sonority (see II3.). Sonority, ‘relative energy noise’ or loudness (Ladefoged 1982:221) plays a crucial role in the relative

<sup>5</sup> And/or a description that refers to features that are located in different gestures (see the discussion on the gesture division in the model proposed in Lass (1976)) (Anderson and Ewen 1987:142-44).

positioning of segments in the syllable (cf. Hooper 1973). The segment types in between the  $|V|$  and  $|C|$  extremes are characterised by the co-presence of  $|V|$  and  $|C|$  in varying proportion (Anderson and Durand 1986:35), as presented in (6) (Anderson and Ewen 1987:151-58) (see below).

(6)	V	V	V	V:C	V:C	C	C
		V:C	C	V		V	
	vowel	liquid	nasal	voiced fricative	voiceless fricative	voiced plosive	voiceless plosive

With regard to the distribution of segment types in the syllable, the representation given above expresses that they function as different entities in the same phonological dimension. The hierarchical or scalar interrelations become clear, namely in terms of the proportion of  $|V|$ -ness, i.e. sonority. Unary components can be either present or absent; vowels are characterised by the presence of  $|V|$ , and  $|V|$  is absent from the specification for voiceless plosives. If two components, in this case  $|V|$  and  $|C|$ , are part of a (sub-) gesture simultaneously, they can either simply combine ( $\{C,V\}$ ),<sup>6</sup> or they can enter in a combination that expresses a dependency relation between the components. Unilateral dependency between  $|C|$  and  $|V|$  is expressed in the characterisation for nasals and voiced plosives above (represented by means of a vertical line), where the  $|V|$  component is more prominently present in nasals, and is the dependent component in voiced plosives (*vice versa* for  $|C|$ ). In the representation of voiced plosives, then,  $|C|$  is the head and  $|V|$  its dependent. In the representation for voiceless fricatives,  $|V|$  and  $|C|$  are mutually dependent (represented by means of a colon); they both contribute to the same extent to the phonological and acoustic character of this natural class (1987:186).

The characterisation of the consonant classes, on the one hand, reflects the sonority of the different segment types. On the other hand, it expresses complexity. This aspect will be discussed

<sup>6</sup> Note that the simple combination (' ') 'implies that [lexically] there is no other combination of the components in question' (Anderson and Ewen 1987:31). If this is not the case, and if both components each contribute an equal share to the (acoustic/phonological) character of the segment, the notation requires ':', e.g.  $\{C:V\}$ .

in 4.4, where the dependency notation will be evaluated with direct reference to early phonological acquisition.

### 4.3 Place of articulation - articulatory gesture

The other gesture of primary interest to the discussion regarding early phonological acquisition is the articulatory gesture, where place of articulation is represented (see Figure 2). Both vowels and consonants are characterised by monovalent components that enter into dependency relations similar to those discussed in relation to the phonatory sub-gesture (4.2) (Anderson and Ewen 1987:206-46).

The characterisation of vowels is based on the basic triangular vowel system /i, a, u/, and is grounded in phonetic theory, in accordance with the natural recurrence assumption (1). The vowel components are presented in (7) (in articulatory and acoustic terms, respectively) (Anderson and Ewen 1987:28, Anderson and Durand 1986:25):

(7)	i	frontness/palatility	or	acuteness and sharpness
	a	lowness	or	compactness and sonority
	u	roundness	or	gravity and flatness
	ə	centrality		

For example, |i| represents a front, non-low, unrounded vowel, e.g. [i]. |i,u| represents a front, non-low, rounded vowel, e.g. [y], where roundness is added by the |u| component. |i,ə| represents a high, unrounded, front vowel that is less front than |i|, e.g. [ɪ] where |ə| describes central and centralised vowels, in general (1986:27).<sup>7</sup>

A vowel system with the vowels /i, e, ɛ, æ, ɑ, ɒ, ɔ, o, u/ can be characterised by the unary components in the following way (where '⇒' indicates unilateral dependency, and '⇔' mutual dependency) (Anderson and Ewen 1987:31):

<sup>7</sup> When a central vowel functions as a reduction vowel rather than in a phonemic opposition (for instance, [ə] is the result of neutralisation of other vowels or vowel components), and it lacks any contrastive components (i.e. a non-front, non-round, non-low vowel), it is represented without any articulatory specification (Anderson and Ewen 1987:220).



(8)	{ i }	/i/	/u/	{ u }
	{ i ⇒ a }	/e/	/o/	{ u ⇒ a }
	{ i ⇔ a }	/ɛ/	/ɔ/	{ u ⇔ a }
	{ a ⇒ i }	/æ/	/ɒ/	{ a ⇒ u }
	{ a }	/a/		

This representation reflects the relative markedness of the vowels in the complexity of the relation between and number of vowel components (see 1.4.1).

In the articulatory gesture, consonants are represented in a similar way to vowels in the dependency phonology notation, though with less recourse to dependency; monovalent components occur on their own or in combination in segmental specification. The components that describe place of articulation are:<sup>8</sup>

(9)	u	<i>gravity</i>	:	{ u }	labials
	l	<i>linguality</i>	:	{ l }	alveolars
				{ u,l }	velars
	d	<i>dentality</i>	:	{ l,d }	dentals
				{ u,d }	labio-dentals
	λ	<i>laterality</i>	:	{ l,λ }	lateral alveolar
	i	<i>palatality</i>	:	{ l,i }	palatals
	a	<i>lowness</i>	:	{ l,u,a }	uvulars

The lingual component groups together those articulations that are produced by the blade or body of the tongue as the active articulator, i.e. dentals, alveolars, palatals and velars (Anderson and Ewen 1987:235-37).

#### 4.4 Acquisition process

The early phonological contrasts (II3.) are expressed in terms of dependency phonology (Anderson and Ewen 1987) in (10). This is the basis on which this notational model will be

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<sup>8</sup> For a discussion on the motivation of these components, see Anderson and Ewen (1987:233-57). Additional components, which are not relevant to the discussion here, are: |t| apicality, |r| retracted tongue root, |α| advanced tongue root.

evaluated with regard to early phonological development.<sup>9</sup> The shaded representations are the members of the new contrast in each stage.

(10)	i.		<b>oral stop</b>  C	<b>nasal stop</b>  C,V	
	ii.		<b>oral stop</b>  C	<b>continuant</b>  C⇒V	<b>nasal stop</b>  V⇒C
	iii.	<b>labial stop</b>  C   u	<b>oral stop</b>  C	<b>continuant</b>  C⇒V	<b>nasal stop</b>  V⇒C
	iv.	<b>labial stop</b>  C   u	<b>oral stop</b>  C	<b>fricative</b>  C⇒V	<b>nasal stop</b>  V:C
					<b>liquid</b>  V⇒C

From the representation of the early stages of phonological acquisition in (10), it becomes clear that the entities that are acquired earlier, i.e. in a system with less phonological contrasts, are represented by means of less complex structure. The degree of complexity is a direct consequence of the state of the phonological system as a whole. The representation of contrastive entities in earlier stages is thus adapted in later stages to a more complex representation, i.e. (more complex) dependency relations and/or a greater number of components, if required. There is thus a gradual building up of complexity. In this way, dependency phonology offers a flexible system of representation that directly reflects the constantly changing nature of the child's early system, and is also able to express less specific phonemes (see I5.5). No structure that is motivated on basis of adult phonological phenomena is assumed for the representation of the child system as such. More specifically, the components that are used in the characterisation of the early child contrasts are defined in acoustic terms, and directly express sonority. In combination with the dependency relations between the components, relative sonority, which is the underlying notion of the

<sup>9</sup> Note that |C| is maximally opposed to |V|, the representation for vowels. In a later proposal, Anderson (1994) proposes that as the default realisation of the phonatory sub-gesture is a vowel, vowels are not specified. |V| represents the most vowel-like natural class, i.e. liquids. This would imply that liquids are less complex as a natural class than fricatives, for example. Given that less complex segments are assumed to be acquired before more complex segments, and given that liquids are established in the child's system after stops, fricatives and nasals, the representation |V| for liquids does not seem appropriate for the early stages of phonological acquisition. (However, see I2.4. and I4.3) With regard to the non-specification of vowels, though, this would predict that vowels are the first entities or default output to occur in the child's early utterances; a strong and accurate prediction.

acquisition of the contrasts in stages i., ii. and iv., is clearly indicated. So, the relative and scalar nature of sonority is expressed by means of meaningful components.

The initial consonantal contrast, manifested by oral stop *v.* nasal stop, is represented as  $|C|$  *v.*  $|C,V|$  (10i.). The  $|C|$  specification characteristically represents a plosive, and consequently,  $|C,V|$  is not a plosive. The notation thus sheds light on the inherent character of this opposition. Also, nasal can on this basis be regarded as the unmarked non-plosive segment. In (10ii.), new specifications are formed through the manoeuvring of  $|V|$  elements. The addition of the continuant entity to the child's phonological representation requires an specific specification of the relation between  $|C|$  and  $|V|$  elements in the existing representation (rather than simple combination) for nasal stop, or non-plosives. The typical characterisation for obstruents at stage ii. is  $\{|C| (\Rightarrow)\}$ . Regarding stage iv., the contrast fricative-liquid requires a specification for the contrastive entities which entails a more prominent role for  $|V|$  in the liquid representation (more sonorous) and a less prominent role for  $|V|$  in the continuant specification (less sonorous) than in the nasal entity. This thus illustrates the continuation of  $|V|$  manoeuvring and/or addition to existing structure to characterise new contrastive entities, and to gradually build up structure. Dependency phonology can be concluded to reflect the early stages discussed here concerning natural classes and manner features in an insightful way.

The representation of place in stages i.-iv. concerns the contrast labial *v.* non-labial for plosives, where only labial is relevant (in accordance with the basic character of a privative opposition). Later stages, however, show a contrast labial *v.* alveolar *v.* velar that has developed out of the labial *v.* "rest" opposition (see II3.). The representation suggested for these three places of articulation in dependency phonology is as follows:

(11)	labial	alveolar	velar
	$ u $	$ l $	$ u,l $

Given that labial is acquired first, represented by the  $|u|$  component, the expectation is that all natural classes that are characterised by  $|u|$  are stabilised before those that do not contain  $|u|$  in the locational sub-gesture. Velar, however, alternates with alveolar, which is captured by the lingual component, and the representation of place appears to be in disagreement with the data

observations regarding the order of place acquisition. A similar situation arises for the place description in the framework of Jakobsonian features (see discussion 2.1), where labial is [+grave, -compact], velar [+grave, +compact] and alveolar [-grave, -compact]. Neither [+grave], nor [-compact] is an appropriate candidate, and the unique and contrastive specification for labial, which is the first place of articulation in the child's phonological system, posits a bit of a dilemma. What is different in the dependency phonology representation of place, however, amongst others, is the assumption of the relativity of components' contribution. The representation for velar, when in opposition with labial and alveolar, is the grave component [u] and the lingual component [l] in simple combination.

Each component in the [representation] is equal, but each is perceptually less strong than when it appears as the only component in the [representation] for a segment ... (Anderson and Ewen 1987:29).

This, then, explains why, when [u] is acquired, it represents labial only. The [u] component in the velar articulation is perceptually less strong, or the representation including it more complex (a combination of different acoustic properties). (See also the discussion on place of articulation in 7..)

Regarding both manner and place of articulation, the representation of the contrast in stages i.-iv. of the acquisition of phonology in terms of dependency phonology proves adequate, and even insightful. The contrasts that are based on relative sonority are expressed with direct and clear reference to this scalar property. The representation of the acquisition process reflects complexity in that the early contrasts are represented by means of less complex structure and later contrast by more complex structure.

## 5. Radical CV phonology and acquisition

### 5.1 **Model**

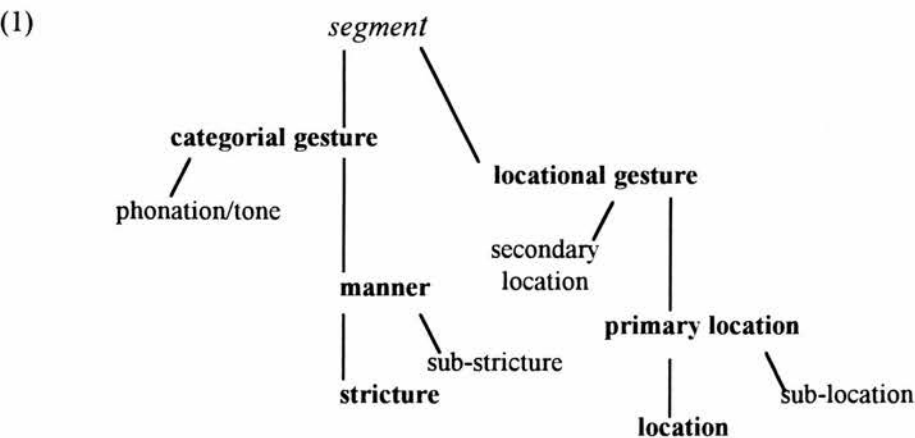
Radical CV phonology is a direct descendant of dependency phonology. Van der Hulst (1995a, b) discusses radical CV phonology, and indicates how this proposal concerning phonological categories at the segmental and syllabic level differs from dependency phonology (see 4.). The discussion here will concentrate on the representation of place and manner in relation to the consonantal development in the early stages of phonological acquisition.

Rather than adopting a small number of at least partially distinct components for both the locational and the phonatory sub-gesture, amongst others (see 4., Figure 2), radical CV phonology assumes that all sub-gestures contain two elements only, namely  $|V|$  and  $|C|$ . A consequence of this claim is that ‘ultimately  $|C|$  and  $|V|$  no longer have intrinsic phonetic content ...’ (1995b:7). In this respect, it is proposed that:

[Universal Grammar] does not contain a list of features, but rather a more abstract set of categories (defined in terms of CV-constellations) that the language learner links with phonetic exponents of various (phonetic) sorts (1995b:7).

Implicit in our discussion is the claim that there is *no* innate set of features. Rather what is innate is a capacity to parse a limited set of discrete categories from the available phonetic “scales”, and a limited syntax for combining these categories (1995b:31).<sup>1</sup>

The segmental structure proposed for radical CV phonology is divided in (sub-)gestures, as presented in (1) (1995b:8):<sup>2</sup>



<sup>1</sup> Van der Hulst (1995b) appears to reject innateness in Chomsky’s terms, and can be placed near Pinker on the innate/learned axis (see Figure 1, II.).

<sup>2</sup> I will discuss the radical CV phonology model as it is discussed in van der Hulst (1995b). The focus of the discussion here is not on the differences between the different versions of this “model-in-progress”.

In the basic segmental structure in (1), left-branching sub-gestures are specifiers (phonation/tonal and secondary location), and right-branching sub-gestures are complements (sub-structure and sub-location). (Note the analogy with syntactic structure; hierarchically branching specifiers and modifiers.) The gestures and sub-gestures are engaged in dependency relations. These relations are claimed to be fixed, which is different from the variable relations in dependency phonology (1995b:8). (In dependency phonology, the presence and nature of dependency relations are system-dependent.) In radical CV phonology, the categorial gesture is the head and the locational gesture is dependent. This structure is based on the spreading behaviour of the different properties located in these gestures; stricture properties are claimed not to spread, whereas location properties do spread. Also, head properties are expected 'to be visible in the "root node"' (1995b:9), and as the stricture properties determine the position of segments in the syllable, the categorial gesture is to be head. Within the categorial gesture, the stricture sub-gesture is the head and the other two sub-gestures, sub-structure and phonation/tonal, are dependents. For these dependents, 'closeness to the head entails resistance to spreading, the head itself being the champion of immobility' (1995b:9).

The oro-nasal sub-gesture in dependency phonology is not reflected in the radical CV phonology segment structure given above. Nasality is assumed to be expressed in terms of the categorial gesture, namely in the phonation sub-gesture (1995a:89-90, 92-93).<sup>3</sup>

There are exactly four categories in each sub-gesture according to the claim posited in radical CV phonology. These categories all have a phonetic interpretation depending on the (sub-)gesture in which they occur, and are expressed in terms of C and/or V as in (2) (1995b:9). ( $C_V$  is a notational variant of dependency phonology  $|C \Rightarrow V|$  (van der Hulst 1995a:95), see 4.2-3.)

(2)                    C                     $C_V$                      $V_C$                     V

<sup>3</sup> Dependency phonology offers a dual expression of nasality; in terms of the categorial gesture (in terms of proportions of  $|C|$  and  $|V|$ ) and in the oro-nasal sub-gesture ( $|n|$ ), based on the behaviour of nasals that form a natural class with both sonorant consonants and nasalised segments (Anderson and Ewen 1987:250-51) (Cf. den Dikken and van der Hulst 1988:11-12). As the initial contrasts between the child's segments are based on sonority, the expression of nasal outwith this dimension, i.e. categorial gesture in dependency phonology, will not be discussed.

Two of the four categories in (2) are nuclear (C-headed) and two are non-nuclear (V-headed). For each pair, one member is unmarked (no subscript feature, or simple) and the other is marked (complex). These four units are the phonological atoms at the lowest level of representation. Reference can be made to the different parts of these atoms. However, they can not be manipulated, or be active individually in a phonological process (van der Hulst 1995b:10). This state of affairs is 'an attempt to *explain* (rather than stipulate) the *number* of categories as well as *markedness asymmetries* holding among these' (1995b:10). The parallel notation in the different sub-gestures makes it also possible to express related categories across (sub-)gestures (see below). The interpretation of the basic categories in the different sub-gestures is given in (3) (*cns* = consonants) (1995b:11, 18). (For the motivation of each of the four categories in each sub-gesture, see van de Hulst (1995a, b).)

(3) CATEGORIAL GESTURE

	<u>phonation</u>	/ <u>tone</u>	<u>stricture</u>	<u>sub-stricture</u>
C	ejective/glottal	high	stop	central closure
C <sub>v</sub>	aspirated/voiceless	high-mid	continuant	approximant
V <sub>c</sub>	prenasal/nasal	low-mid	sonorant cns	lateral
V	voice/implosive	low	vowel	strident

LOCATIONAL GESTURE

	<u>secondary location</u>		<u>location</u>	<u>sub-location</u>
C	palatalised	fronted	coronal	front
C <sub>v</sub>	labialised	rounded	labial	round
V <sub>c</sub>	–	–	high	–
V	pharyngeal	retracted	low	posterior

In the phonation/tone sub-gesture and in relation to a segment in nuclear position (i.e. a vowel), the four CV-categories express tone properties (*high*, *high-mid*, etc.). Non-nuclear segments are specified for the phonation properties in that sub-gesture (*ejective*, *aspirated*, etc.). The phonation/tone sub-gesture is thus related to the stricture sub-gesture in terms of the contents of these sub-gestures, and not merely through dependency relation. In a similar way, the properties in the secondary location sub-gesture (locational gesture) are also dependent on the stricture (or manner of articulation) sub-gesture. The secondary location properties for consonants are *palatalised*, *labialised*, etc.; for vowels: *fronted*, *rounded*, etc.



The interpretation of  $V_C$  in the locational gesture is not straightforward, as is evident from the blanks in the overview of the phonological atoms and their (sub-gesture dependent) interpretation. Van der Hulst (1995b:21) states that there is 'an overgeneration of structure in the case of the consonantal place properties ... labials and coronals make no use of sublocational  $V_C$ '. A consequence as well as a drawback of the assumption of the  $V_C$  atom in the location sub-gesture is that the vowel space is envisaged as rectangular (cf. the triangular model in dependency phonology, 4.). This 'is forced upon us by the internal logic of the system that we advocate here' (1995b:21). A direct effect of this system, pointed out by van der Hulst (1995b:21), is that the representation of the two vowel systems that are presented in (4a.-b.), in the context of a rectangular vowel space characterisation, does not give any indication that the (b.) system has never been attested.

(4)	a.	i	u	b.	i
		a		æ	A

The strategy chosen to deal with this anomaly is to limit the possible expressions in the locational sub-gestures, thereby still maintaining the claim that the representation in the locational and the articulatory gesture are fundamentally similar, namely by means of CV-constellations. So,  $V_C$  is excluded from the locational gesture, expressed by a well-formedness condition (1995b:22).<sup>4</sup>

Relevant to the discussion of early phonological development is the representation of place of articulation and manner categories, i.e. the representation in the location and stricture sub-gestures. The relationship between sub-stricture and stricture, and between location and categorial gesture concerns the type of dependency relation these (sub-) gestures hold in relation to one another, namely a modifier-head relation, and also the specification in these (sub-)gestures. There is a 'selectional restriction on the combination of head units and complement units' (1995b:11), according to the Head-Complement Polarity principle. For instance, stricture and sub-stricture are

<sup>4</sup> This constraint is considered "soft" in that it can be violated to satisfy the Head-Complement Polarity principle that does not allow empty heads (see below in main text). So,  $V_C$  can occur in the locational gesture (see van der Hulst 1995b:22). It is also noted that  $V_C$  lacks the property of being fully pronounceable on its own because its acoustic properties are minimal (1995b:34, footnote 17).



The notion of 'possible phonological segment' is to be ensured by the CV-only-representation of phonological categories in the radical CV phonology notation. Restrictiveness is thus claimed to be better handled in radical CV phonology. The attempt to explain rather than stipulate the number of categories is an ambitious one. However, the logical combinations of CV in the various gestures do not appear to correspond to the number of categories that are needed or wanted in a phonological theory (see above). Different stipulations regarding the possible combinations are stated. For instance, the Head-Complement Polarity principle and the agreement between the categorial and locational head. In these cases, the notation or explicit syntax of radical CV phonology generates too many categories, and these are restricted in a way that is *ad hoc* in relation to the CV-notation and its possible combinations.

Moreover, the attempt to define the 'number of categories' in terms of fixed CV-combinations reflects an invariant universal outlook on representation. This assumes, for instance, that lateral liquids have the representation (V<sub>c</sub> V), and that this representation does not relate to the contrasts present in the system of which these liquids are part. Dependency phonology, on the other hand, emphasises the aspect of system-dependent representations. The complexity of the specification of contrastive segments depends on the total number and the identity of the contrast in the system. Again, with regard to the voiced lateral fricative, /ɮ/, this segment is assumed to have the presentation given above on basis of its contrastive relations with all other segments in the system, one of which is /r/, a voiced fricative trill (Anderson and Ewen 1987:164). In this respect, the representation can be said to be language-specific. The dependent |C| characterises a stricture type within the phonatory sub-gesture, namely, the central closure of laterals.

A complex structure such as the one proposed for the voiced lateral fricative in (5) is only called into action when necessary on the basis of the contrasts present in the system. As a consequence, it does not directly affect the representation of fricatives in other systems/languages. Thus in terms of van der Hulst (1995b:31), (the general view is that) the set of elements and thus of possible segments is not as enumerated as is demanded by the system that it characterises. Indeed, given the different demands of different systems in terms of contrasts to be expressed, it is not sure how a "fixed" representation such as the proposed CV-constellation in van der Hulst (1995b) can be of an appropriate number for both a simple and a complex system. Also, given the "man-handled", rather than logically restricted, posited restrictions on the segmental system, it is not clear whether the proposal in the form in which it is presented in van der Hulst (1995b) is successful. As the

discussion here is in the first place concerned with the assessment of this theory in relation to language acquisition, the theory internal discussion of radical CV phonology is not continued here.

The representation of the natural classes in terms of the radical CV phonology notation are listed in (6) (1995b:12, 28), as a point of reference for the acquisition account (5.2). On the assumption that in the locational gesture only the specification in the location sub-gesture is relevant to the early stages of the acquisition process, the dependent options are not given.

(6) <u>Manner</u>				<u>Place</u>	
C	stop	:	$\begin{array}{c}   \quad \backslash \\ C \quad V \\ \text{strident stop} \end{array}$	$\begin{array}{c}   \quad \backslash \\ C \quad V_C \\ \text{lateral stop} \end{array}$	C coronal (stricture in oral cavity)
		:	$\begin{array}{c}   \quad \backslash \\ C_V \quad V \\ \text{strident fricative} \end{array}$	$\begin{array}{c}   \quad \backslash \\ C_V \quad V_C \\ \text{lateral fricative} \end{array}$	C <sub>V</sub> labial (stricture outside oral cavity) <sup>5</sup>
V <sub>C</sub>	sonorant consonant (r-sounds)	:	$\begin{array}{c}   \quad \backslash \\ V_C \quad C \\ \text{lateral liquid} \\ \text{(nasal consonants)} \end{array}$	$\begin{array}{c}   \quad \backslash \\ V_C \quad C_V \\ \text{fricative trill} \end{array}$	V <sub>C</sub> high (broad outflow of air)
		:	$\begin{array}{c}   \quad \backslash \\ V \quad C \\ \text{tap} \end{array}$	$\begin{array}{c}   \quad \backslash \\ V \quad C_V \\ \text{approximant} \end{array}$	V low (narrow outflow of air)

## 5.2 Acquisition process

The characterisation of the development of the early contrasts in the child's phonological system in terms of radical CV phonology looks as follows (categorical specification left, locational specification right):

(7) i.		<b>oral stop</b>		<b>nasal stop</b>	
		C		V <sub>C</sub>	
ii.		<b>oral stop</b>	<b>continuant</b>	<b>nasal stop</b>	
		C	C <sub>V</sub>	V <sub>C</sub>	
iii	<b>labial stop</b>	<b>oral stop</b>	<b>continuant</b>	<b>nasal stop</b>	
	C C <sub>V</sub>	C	C <sub>V</sub>	V <sub>C</sub>	
iv	<b>labial stop</b>	<b>oral stop</b>	<b>fricative</b>	<b>nasal stop</b>	<b>liquid</b>
	C C <sub>V</sub>	C	C <sub>V</sub>	V <sub>C</sub> C	V <sub>C</sub>

<sup>5</sup> '[T]he choice for [the representation of] labiality also crucially depends on the internal "logic" of the system' that is proposed (van der Hulst 1995b:20).



Non-specification of velar is explained by the fact that 'references to dorsal as the "weakest" place of articulation are too numerous to cite' (1995b:19). Neither the correctness of this claim and the "weakness" of velars, nor the diminished perceptual properties of labial in relation to alveolar (labial is acquired before alveolar; see II5.) becomes clear from the data studied here. However, on the basis of the non-specification of velar in radical CV phonology, velar is predicted to be the first place of articulation to appear in the child's output. Namely, in the absence of any place contrast in the child's system, no specification is present, thus leading to a velar interpretation. This is i.) not observed, and ii.) not in agreement with the claim (related to the non-specification) that dorsal is perceptually unclear and a "weak" place of articulation that is consequently assumed to be marked and thus to be acquired late(r). Also, non-specification of velar would predict the filling-in of velar segments (cf. labial filling-in, see II5.). This is not observed in the data either. The marked specification of the labial segment can not be reconciled with its status of being acquired first.

In conclusion, the intended restrictiveness of structure appears to be not entirely successful as some of the logical possibilities are ruled out by additional constraints. The proposed representation in terms of CV-constellations for place of articulation does not suffice for the description of the early development of phonological contrasts. The predictions expressed by the non-specification of velar and the complex representation of labial are not in agreement with the data findings. The manner representation reflects sonority. However, nasal stops are represented as being more complex than, for instance, liquids, and this does not reflect the early acquisition of nasals. So, radical CV phonology does not offer an improvement over its predecessor, dependency phonology, from an acquisition point of view.



## 6. Articulatory phonology and acquisition

Articulatory phonology has been presented in the literature with direct reference to (the description of) child language (Browman and Goldstein 1989, 1992a). In this respect, this notational model is different from those discussed in 2.-5.; binary features, feature geometry, dependency phonology, etc. are not inherently associated with the acquisition process, and these models are merely applied to child data. Articulatory phonology makes specific claims regarding the description of early phonology. As a consequence, the discussion here takes a slightly different form from 2.-5.. Firstly, the foundations and claims of articulatory phonology are studied (6.1). Subsequently, the claims regarding the child's early forms are studied (6.2), and, more specifically, the representation of the early oppositions in the child's phonological acquisition are discussed (6.3).

### 6.1 **An outline of articulatory phonology**

Articulatory phonology is an approach to notational theory proposed by Browman and Goldstein (1986, 1989, 1992a). It has developed as a reaction to, among other things, the feature matrices of linear phonology that express a 'strictly linear view of the relation between linguistic units and speech' (Browman and Goldstein 1986:219) (see 1.1). These matrices are unable to express temporal overlap of features in adjacent matrices, and the 'traditional link between phonological and physical structure has vanished' (1986:220). Also, the observation that the linear view on structure does not express different temporal relations amongst articulatory structures, i.e. (a significant subset of) phonetic differences, is perceived as problematic. '[I]nterarticulator temporal organisation may vary from language to language in a way that cannot be predicted (by any universal principles) from existing phonetic feature characterisations' (1986:220). Browman and Goldstein claim to '[account] as simply as possible for the organisation of speech in both space and time', thus aiming at a new formulation of the relation between phonological structure and articulatory movement (1986:220).

The basis unit in the representation proposed by articulatory phonology is the gesture. A gesture reflects the trajectory of a particular articulator, or, rather, an instance of a family of trajectories. In terms of articulators, /b/, for instance, represents a family of patterns of lip movement, all members of which are an instance of /b/. At the same time, these members can be different (within limits) from any other member, depending on vowel context, syllable position, stress, speaking



rate and speaker (1986:223-24). A gesture involved in a particular utterance is part of a larger structure or constellation, the gestural score (Browman and Goldstein 1989:206).

The description of the velic and glottal gestures requires only one tract variable or specification, namely for aperture size or constriction degree (CD). Oral gestures, on the other hand, involve tract variables for both constriction degree and constriction location (CL) (1989:208). The different tract variables (as proposed in Browman and Goldstein 1992a) are presented below, with an indication of the articulators involved (1992a:157).

(1)	<i>tract variable</i>	<i>articulators involved</i>
<b>Lips</b>	lip protrusion (LP)	upper and lower lips, jaw
	lip aperture (LA)	upper and lower lips, jaw
<b>Tongue Tip</b>	tongue tip constrict location (TTCL)	tongue tip, tongue body, jaw
	tongue tip constrict degree (TTCD)	tongue tip, tongue body, jaw
<b>Tongue Body</b>	tongue body constrict location (TBCL)	tongue body, jaw
	tongue body constrict degree (TBCD)	tongue body, jaw
<b>Velum</b>	velic aperture (VEL)	velum
<b>Glottis</b>	glottal aperture (GLO)	glottis

Each tract variable is thus specified for the articulators involved, and also for 'parameters in the dynamic equation' (1992a:156). These parameters describe the exact movement or the spatio-temporal event executed by the articulators, and can be described by means of dynamical equations, which describe the co-ordination and control of skilled motor actions in general (Browman and Goldstein 1991:314).<sup>1</sup> This approach and its subsequent 'motoric terminology' that is used to characterise the phonetics/phonology of speech make it possible to describe speech and sign language in analogous terms (Studdert-Kennedy 1991:89).

<sup>1</sup> The kind of task dynamic model that is discussed in relation to speech in the articulatory phonology literature is adapted from a 'model used for controlling arm movements, with the articulators of the vocal tract simply substituted for those of the arm' (Browman and Goldstein 1991:314). To illustrate the dynamics that are assumed for the articulators, a simple dynamic system is discussed (a mass attached to the end of a spring) and its equation ( $m\ddot{x} + b\dot{x} + k(x - x_0) = 0$ ;  $m$  = mass of the object,  $b$  = damping of the system,  $k$  = stiffness of the spring,  $x_0$  = rest length of the spring (equilibrium position),  $x$  = instantaneous displacement of the object,  $\dot{x}$  = instantaneous velocity of the object,  $\ddot{x}$  = instantaneous acceleration of the object) (Browman and Goldstein 1989:245, footnote 1).

Gestures, on the one hand, reflect the actual movements of the articulators; on the other hand, they embody the units of contrast in terms of the speaker's phonological system (Browman and Goldstein 1989:210).

... for contrasting gestures that employ the same tract variables, the difference between the gestures is in the tuned values of the continuous dynamic parameters (for oral gestures: constriction degree, location and stiffness)' (1989:208).

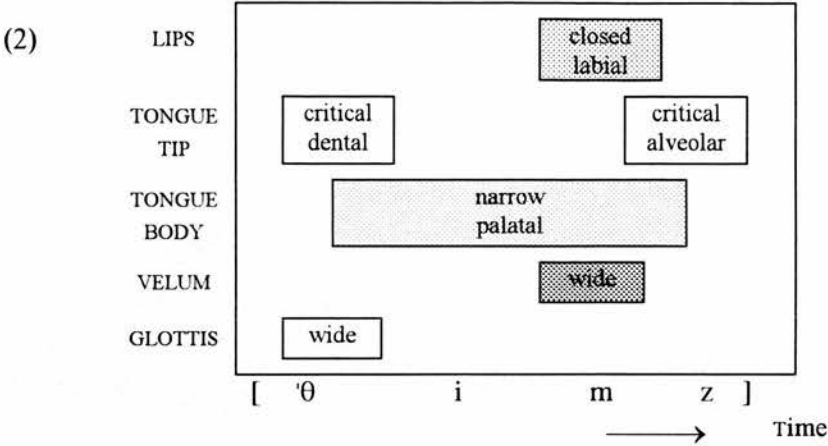
[gestural] descriptors serve as pointers to the particular articulator set involved in a given gesture, and to the numerical values of the dynamical parameters characterising the gestures (1989:209).

With regard to constriction degree, the following descriptors are proposed to complement the specification of the oral gestures: *closed*, *critical*, *narrow*, *mid*, *wide*. The constriction location descriptors are: *protruded*, *labial*, *dental*, *alveolar*, *post-alveolar*, *palatal*, *velar*, *uvular* and *pharyngeal* (1989:209). These two sets of gesture descriptors are reminiscent of manner and place of articulation, respectively.

As the description of the actions of articulators, gestures are characterisations of movement through space, as well as time (1989:201). 'Correct execution of an utterance requires accurate timing of the gesture itself, and accurate phasing of gestures with respect to one another' (Studdert-Kennedy and Goodell 1995:70). In articulatory phonology, the time aspect is described in terms of stiffness, which is a third type of descriptor for oral gestures. The motion of a particular articulator, or rather the speed it moves at, depends on the stiffness of that articulator (similar to a spring and its oscillation) (see Browman and Goldstein 1989:208; 245, footnote 1; and 1986:238-39).

So, a gestural score specifies the values for the dynamic parameters for each gesture (Browman and Goldstein 1989:206), and thus describes the characteristic organisation of the gestures utilised for a specific utterance (Browman and Goldstein 1991:317-18). This representation of the co-ordination of the gestures embodies the phonological structure for the utterance. The lexical entry for *themes*, for example, looks as follows (adapted from Browman and Goldstein 1989:218, Figure 7a.):<sup>2</sup>

<sup>2</sup> The different degrees of shading in (2) serve to distinguish the different gestures, and do not have any representational meaning.



The notation proposed in articulatory phonology is claimed to characterise different types of language patterns that can be analysed in terms of gestural variation, such as the misorderings of disordered speech and historical changes (1989:244). More specifically, ‘changes in the patterns of overlap between neighbouring gestural units can automatically produce a variety of superficially different types of phonetic and phonological variation’ (1989:211). Examples are acoustic non-invariance, allophonic variation, co-articulation and alternations in fluent speech (for a more detailed discussion, see 1989:214ff.).

## 6.2 Articulatory phonology and the acquisition of phonology

### 6.2.1 Pre-linguistic and linguistic gestures

Browman and Goldstein (1989) advocate gestural representation instead of featural representation generally, and they propose that gestures, i.e. discrete units of action, are ‘particularly useful for a child learning to speak’ (1989:202).

If we assume that discrete gestures (like those that will eventually function as phonological units) emerge in the child’s behavioural repertoire *in advance* of any specifically linguistic development, then it is possible to view phonological development as harnessing these action units to be the basic units of phonological structures (1989:202).

For the sake of the argument, the assumption that gestures are an adequate and insightful means of representation for the adult phonological system is adopted here. (See Hind (1997) for a detailed discussion of the articulatory phonology model and some problematic aspects therein (e.g. the representation of gradient *v.* categorical information).) The focus of discussion here is on the description of early phonological development.

The 'evidence' that supports the assumption that gestures are evident and appropriate in prelinguistic output is found in babbling (Browman and Goldstein 1989:202), which is basically a repetition of CV syllables (canonical babbling). The consonantal part of these syllables can be regarded as combinations of gestures, for instance, /m n/ 'combine oral constrictions with velic lowering' (1989:203). This 'analysis' suggests that during babbling, parts of the vocal tract are for the first time involved in simple constriction gestures. This is not considered to reflect an ability on the part of the child 'to co-ordinate gestures' (1989:203). Indeed, following Locke (1983, 1986), the anatomical and neurophysiological development of the vocal tract is the source of the emergent gestural activity. It is not regarded as the beginning of the child's linguistic period (as opposed to pre-linguistic) on basis of the following: i) babbling development and inventory do not appear to be language-specific, ii) frequency changes of consonants can be explained by anatomical development, i.e. maturation of the vocal tract, and iii) the repetitive element in babbling coincides with repetitive motor behaviour generally, and is considered a non-linguistic development (Browman and Goldstein 1989:203-4).

So, the gestural combinations that are observed in the pre-linguistic or babbling period are not regarded as being linguistically relevant as such, in the sense that they reflect the child's ability to distinguish and produce the contrasts that are established in his "system". According to Browman and Goldstein (1989), however, '[i]t is possible to establish that there is a definite relationship between the (non-linguistic) gestures of babbling and the gestures employed in early words by examining individual differences among children' (1989:204). Research in Vihman (1991) is quoted to support the claim that consonants that are used frequently in babbling are subsequently applied for a new task and used in the production of the child's first words.<sup>3</sup> On this basis, gestures or 'discrete units of vocal action' are proposed to represent the child's output before and after the acquisition by the child of a phonological system (Browman and Goldstein 1989:206). Articulatory phonology is thus claimed to have the advantage of the ability to describe pre-linguistic behaviour or babbling, which does away with (part of) the 'problems inherent in using a transcription that assumes a system of units and relations to describe a behaviour that lacks such a system' (Browman and Goldstein 1989:203). At the same time, it raises the question of the

<sup>3</sup> 'It has been established that the phonetic characteristics of a given child's early words will be highly similar to that child's contemporaneous babble (Vihman, Macken, Simmons and Miller 1985)' (Vihman 1991:74).

representation of the child's "abilities". If babbling does not reflect 'an ability on the part of the infant' (1989:203) whilst the child's early words do, and the same description is used for both groups of utterances, how are the child's phonological abilities indicated? This differentiation could be expressed by means of a production/perception model that entails different components, i.e. different parts of the lexicon or of the speech processing model assumed (see I4.), for babbling and phonology. Browman and Goldstein (1989) do not discuss articulatory phonology in the context of such a model. However, for a discussion on the number of lexicons adopted in articulatory phonology, see below (6.2.2).

Whereas Browman and Goldstein (1989) promote the gesture in favour of the feature as representational unit for child language on basis of the former's suitability for the description of the transition from the pre-linguistic to the linguistic, Studdert-Kennedy and Goodell (1995) focus on the rejection of the feature on basis of its inadequacy to describe child language. Their arguments are discussed below.

First of all, the "feature" in Studdert-Kennedy and Goodell (1995) is defined as follows:

... the feature. By this we cannot mean the abstract feature of generative phonology, a relational property fulfilling the linguistic function of contrast across a phonological system, because we are dealing with a child for whom such a system does not yet exist. We must therefore mean the concrete feature, an absolute property ... (1995:66).

This abstract feature is rejected by Studdert-Kennedy and Goodell (1995) as a suitable means of describing child language on the following ground: it can not be the basic unit of speech perception or production because it is a property of a larger entity, and not an independent entity (1995:66, 84). Also, features do not have temporal extension (e.g. binary features), they are abstract units (e.g. features proposed in non-linear phonology) and/or they are purely descriptive and 'certainly not specifications for ... the spatio-temporal pattern of movements by which a speaker ... executes a word' (1995:67) (e.g. Waterson's features) (1995:66-67).

[Studdert-Kennedy and Goodell (1995)] conclude that, despite the utility of the feature as a descriptive and classificatory element in phonetic theory, it cannot guide a child into speech.

In fact, what a child quite evidently needs, to imitate an adult word, is a grasp on which articulators to move where and how, and on when to move them. And what [is required] is a description of the target word in terms of the units of articulatory action, and their relative timing, necessary to utter it (1995:67).

The notational framework adopted is gestural phonology (Browman and Goldstein 1986, 1989). Gestures are proposed to deal adequately with the aspects mentioned; they provide a description with observable, physical content (Studdert-Kennedy 1987:77).

With regard to the statement that what is required for the description of child language is an indication of which articulators to use and when (Studdert-Kennedy and Goodell 1995:67, see above), it is again unfortunate that no model of perception/production is discussed. According to Vihman (1991), each child needs to establish speech gestures and the relation between articulation and acoustic signal by means of auditory feedback. In this light, it does not become clear how a representation based on the timing of articulators can help a child learn a language. Clearly, the auditory signal is what is available to the child, and not the (gestural) representation. The conclusion on the appropriateness of a gestural representation of the child's output is based on that output; it can not be an aide to the child to acquire (more refined) perception or production skills. This becomes evident from Studdert-Kennedy's (1991) discussion of the identity of production and perception; to assume that perceptual representation is present and that the child only needs to learn how to 'actuate these ... control structures' would be

... [to reverse] the normal course of development both evolutionary and ontogenetically: Behaviour builds control structures; control structures do not build behaviour (1991:87-88).

Browman and Goldstein (1992b), however, make it clear that in articulatory phonology the speaker's goal is not auditory. It is stated that '[p]erceptual and quantal effects may help to select the goals (the particular values of a gestures's (*sic*) dynamic parameters) that are lexicalized without changing the fact that what is lexicalized is purely articulatory' (1992b:222). This presents a picture of instantaneous lexicalisation of speech, i.e. acoustic information, into an articulatory representation. Some of the consequences of this rather odd claim become clear below (see 6.2.2 and the discussion on the number of lexicons).

The different kinds of variability, context-dependent and free variability, and the adequacy of gestures to provide an insightful description are discussed in 6.2.3. below.

#### 6.2.2 *Number of lexicons*

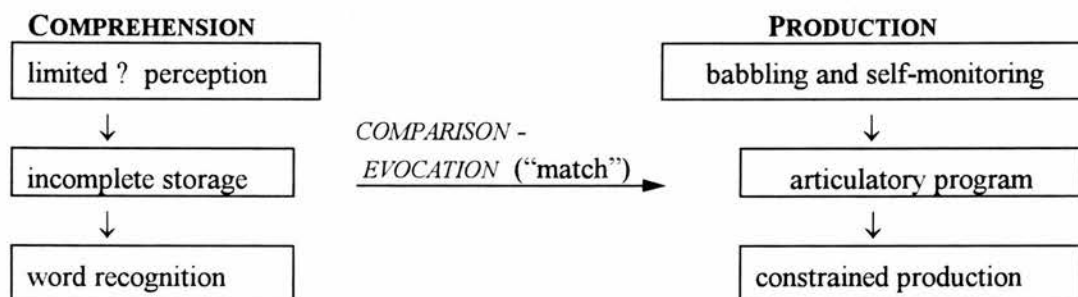
One of the basic assumptions regarding the gestures proposed by Browman and Goldstein is their dual function. Not only are they claimed to characterise the movement of the articulators, they are



also meant to function as phonological primitives (Browman and Goldstein 1992a:156). Thus, no distinction is made between a phonetic and a phonological representation, or component. No modification of this assumption is made with regard to language acquisition. In Vihman (1991), however, separate comprehension (or perception) and production components are assumed for the period of early language acquisition. The former entails incomplete storage of what the child perceives, which is (possibly) limited (cf. the *limited? perception* component in (3)). The child's stored representation is matched with the articulatory program that is used for production.<sup>4</sup>

Vihman (1991:76) presents a model for the comprehension and production of early words, that is presented in (3) below. The developmental period studied is from the emergence of canonical babbling up to the development of a small lexicon, and data is taken into account from deaf v. hearing infants, intra-child differences and children learning different languages. The findings are, amongst others: i) 'auditory input is essential for the normal timely development of a repertoire of adult-like syllables', by means of which babbling is defined (1991:72), ii) babbling offers the opportunity to the child to explore the phonatory and articulatory muscle systems and their possibilities, and it establishes an auditory feedback loop (with reference to Fry 1966). The vocal motor schemes thus established are at the basis of early word production strategies (McCune and Vihman 1987). The child is assumed to recognise and attempt the production of those adult words that resemble his own motor schemes (Vihman 1991:74-77). This is expressed in the comprehension-production model given in (3) (1991:76).

(3)



This view, of two separate representational components, incomplete storage and articulatory program, is supported in Studdert-Kennedy (1991). One of the points discussed in his comment on

<sup>4</sup> Note that Vihman's (1991) study is adopted by Browman and Goldstein (1989) to establish the continuation of gestures from babbling into early words.



Vihman (1991) is the discrepancy between what a child recognises and what a child produces (Studdert-Kennedy 1991:86-87). The child is regarded as being perceptually sensitive to the internal structure of words it cannot produce, as is illustrated by, for instance, strategies of avoidance and selection.

... the supposed identity of perceptual and motor representations [is rejected], because it ... requires that prior, independent perceptual representations (patterns heard) be [*sic*] available for comparison with items in the child's motor repertoire. These patterns heard and stored seem, in fact, to be precisely what keep [*sic*] a child on course in its dogged attempts to get a word right: They are the perceptual targets for which the child has not yet found the gestures.

... the evidence seems clear that the child initially has two independent systems, and input lexicon and an output lexicon ..., very much as Vihman proposes in her model [i.e. Vihman 1991] (Studdert-Kennedy 1991:88).

As mentioned above, the proposal of Browman and Goldstein concerning gestural representation does not propose more than one lexicon or component for the child's perception/production process. (For a discussion on the model for early phonological acquisition, see I4..) Studdert-Kennedy and Goodell (1995) adopt the framework of gestural phonology in their discussion on early child speech, 'in which the basic phonetic and phonological unit is the gesture' (1995:68). No mentioning is made of a representation of the child's perceptual and production "forms" in separate components. This confirms the picture of instantaneous phonological representation presented in Browman and Goldstein (1992b:222) (6.2.1).

Furthermore, Studdert-Kennedy and Goodell (1995) do not comment explicitly on the origin of the 'errors' or 'confusions' the child makes, that is, of the differences between the realisations by the child and the adult target. On the basis of the assumption that phonological acquisition entails the mastering of both production and perception,

... [they] deliberately avoid the question of whether those confusions reflect an incomplete percept (under which we may include incomplete storage of the percept in memory) or inadequate articulatory control (under which we may include failure to recover stored motor commands from memory) (1995:71-72).

If Studdert-Kennedy and Goodell (1995) had opted to answer the question above or provide different alternative explanations, they would not be able to reflect or integrate that in their proposal, as this does not differentiate between production and perception. In this context, their discussion of the output of Emma (2 years) in particular, the variable forms therein, thus presents an interesting test of their gestural account. This aspect of their proposal is discussed in 6.2.3.

### 6.2.3 Variability

One of the phenomena discussed on the basis of the output of a 2-year old child in Studdert-Kennedy and Goodell (1995) is variability. In particular, the child's realisations of target *doughnut* and *peanut* are explained with reference to gestural representation, based on the articulatory phonology framework proposed.

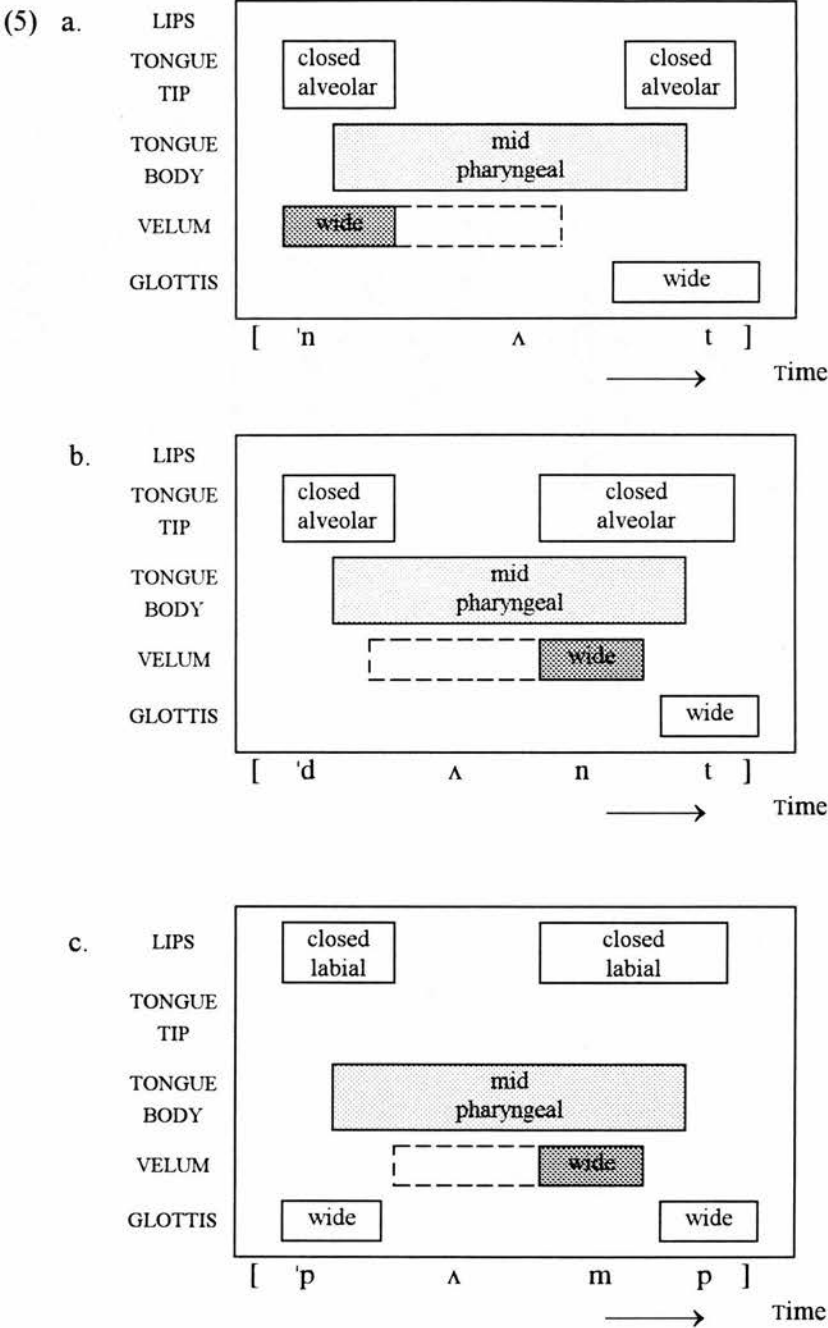
The realisations of the syllable *nut* are variable, as becomes clear from the forms presented.<sup>5</sup> These forms are from different observation sessions, and from different environments, i.e. words. Assuming the comparability of these forms, within the context of the discussion here, they are presented in (4) (after Studdert-Kennedy and Goodell 1995:79, Table 4.3):

(4)	<i>doughnut</i> /dɔ:nʌt/ →	<i>nut</i>	<i>nut</i>	← <i>peanut</i> /pi:nʌt/ <sup>6</sup>
	[dʊ:də]	[də]	[də]	[pe:də]
	[dʊ:n'dʌnt]	[dʌnt]	[tə]	[pe:n'tə]
	[dɔ:di:dʌt]	[dʌt]	[de:]	[pe:de:]
	[dʊ:dʌtʃ]	[dʌtʃ]	[pʌmp]	[pe:m'pʌmp]
	[dʊ:dʌts]	[dʌts]	[pʌp]	[pi:pʌp]
	[dɔ:nʌt]	[nʌt]	[nʌt]	[pi:nʌt]

The different realisation of *nut* by the child are explained on basis of the articulators involved in their production (1995:78-79). For instance, the slow release of an alveolar constriction results in final [ts tʃ] (in [dʌts] and [dʌtʃ], respectively), rather than in [t]; the prolongation of the alveolar closure of [n] after the velum has been released results in [d] in [dʊ:n'dʌnt]. The final cluster in this form is explained as follows: '[a] prolongation of the alveolar closure for final [t] and a shift in (or harmonious repetition of) the medial velic gesture' (1995:79). This can be illustrated by a gestural diagram or score; below the representations of [nʌt], [dʌnt] and [pʌmp] are presented schematically (5a.-c.) (1995:80).

<sup>5</sup> The forms for *doughnut* in Table 4.3 (Studdert-Kennedy and Goodell 1995:79) are not listed chronologically (contrary to the information provided); the forms for *peanut* appear to be listed chronologically, and the realisations of *doughnut* seem to be listed according to resemblance to the realisations of *peanut*.

<sup>6</sup> Studdert-Kennedy and Goodell (1995:79, Table 4.3) give [dɔ:nʌt] and [pi:nʌt], respectively.



The above scores illustrate ‘the timing errors required to make the shift from [nʌt] ... to [dʌnt]’ and [pʌmp] (1995:79), where timing errors refer to the timing of the movements of the articulators. At the same time, the gestural scores describe the child’s output, and constitute his phonetic and phonological representation. Given that the differences between the child’s

realisation and the adult target are generally referred to as “errors” in Studdert-Kennedy and Goodell (1995), the ‘timing errors’ mentioned above are assumed here to refer to some “action” on the part of the child. This in turn would imply that the adult representation of, in this case, [nʌt] is considered to be available to the child. This would point to a perfect perception on the part of the child in order to get the complete representation, and an immature production in order to get variable forms that are different from the target. On the undesirability of this view, see I4.. Also, this would contradict the statement that Studdert-Kennedy and Goodell (1995) take a neutral stance with regard to the source of error of the child’s realisations (6.2.2).

With regard to the gestural scores of the child’s realisation of *nut* as such, the only indication that they concern descriptions of variable or unstable forms is the dotted lines of ‘[t]he extensions of the velic activation intervals ... [that] indicate possible free variation in the duration of the velic gestures’ (1995:81, Figure 4.3). The velic variation gives rise to a nasal element either before or after the vowel. The variability of the place of articulation (labial and alveolar) does not become clear from the individual gestural scores. The representation of [pʌmp] (5c.), for instance, does not indicate that the realisation of labial is variable (cf. [dʌnt] (5b.)) (again, assuming that they are comparable forms), and thus that it is the description of an unstable segment. This appears to be problematic for a phonological representation (an aspect that goes back to the representation of “abilities”, mentioned in 6.2.1).

Besides the representational distinction between variability and stability, the differentiation between context-dependent and free variation is also relevant in the *nut* example (4). The labial segments in [pɛm'pʌmp] *peanut* are claimed to have come about ‘by the substitution of harmonised labial closures for the alveolar closures called for by the target’ (1995:79). When the child produced [pi:pʌp], another realisation for target *peanut*, she was ‘succumbing to labial harmony’ (1995:79). On the assumption that both the substitution and the harmony were motivated by the initial labial segment in the adult target, neither the identity of this harmony source, nor the status of the receiving segment of the harmony spreading become apparent from the gestural score presented. Following Studdert-Kennedy and Goodell (1995), [pi:pʌp] could be explained on the basis that ‘the child cannot easily switch gestures in successive syllables’ (1995:71). The articulatory phonology representation with its gesture-based notation as such lends

itself nicely to express this. However, nothing in the phonological representation of, for instance, [pʌmp] (5c.), to which the same “inability to switch gestures” would apply, expresses the fact that the utterance concerns an articulatory inability to rapidly ‘switch gestures’.

In [pʌmp], the Lips gesture is described as *closed labial*, similar to the *closed alveolar* specification for the Tongue Tip gesture in [dʌnt] (5b.-c.). (For a featural account of consonant harmony or filling-in, see II5..) As the source segment in a consonant harmony situation is not acknowledged representationally, no distinction is made between context-dependent and free variation. This is regarded here as a flaw in notation.

So, the gestural description advocated by Studdert-Kennedy and Goodell (1995) is able to describe the realisations of the child by means of gestural scores. However, it appears to be unable to distinguish between stable and variable forms, and between context-dependent harmony forms and free variation. Browman and Goldstein (1989) discuss the issue of gestural overlap and subsequent assimilation in detail. However, this concerns adjacent consonants, whereas the consonant harmony cases in child language can be regarded as “assimilation at a distance” (Levelt 1994:45).

#### 6.2.4 *Summary*

In Studdert-Kennedy and Goodell (1995), the immaturity of the child’s gestural timing, in comparison with the adult target, is regarded as the main source of ‘error’ or variability (see 6.2.3). Also, the paradigmatic variation within a wordpattern or gestural routine is accounted for in terms of gestural errors (1995:73-78). Gestural timing errors, however, do not seem to be able to account for consonant harmony. The gestural representation by means of a gestural score can not express the (assimilatory) influence of a non-adjacent segment in a straightforward way (see 6.2.3).

Overall, the extent to which the representation of the child’s early phonological abilities is discussed appears to be modest in comparison to the claims that are made (both in Browman and Goldstein 1989, 1992a; and in Studdert-Kennedy and Goodell 1995). The gesture functions both as phonological and phonetic unit. However, it is not clear how one lexical, gestural representation fits in a model of phonological acquisition that is claimed to implement two separate lexicons (Vihman 1991, Studdert-Kennedy 1991) (6.2.2). No distinction is made representationally between stable and variable forms.

As such, the gestural representation of articulatory phonology can describe the child's realisations. On the basis of the discussion in 6.2, it does not seem to provide an insight into the structure of the child's language. In the following section (6.3.1), the representation of the early oppositions of the child's phonological system in terms of articulatory phonology is discussed.

6.3 Early phonological contrasts

In this section, the early contrasts in the child's phonological system are studied with regard to their underlying characterisation. The gestural score proposed for articulatory phonology is considered (6.3.1), as well as the "manner" hierarchy of tube geometry, the articulatory phonology variant of feature geometry (6.3.2). The contrasts that will be discussed are given below.

- (6) i. stop v. vowel
- ii. oral stop v. nasal stop
- iii. oral stop v. continuant

6.3.1 Articulatory phonology

In relation to the opposition stop v. vowel, none of the basic distinctions between articulatory phonology gestures is relevant. Rather, the tract variable constriction degree (CD) expresses the opposition between full constriction and the absence of constriction. More precisely, the dynamic parameter [closed] for *the oral gestures* appropriately describes the contrastive stop entity. Vowels are described by means of the Tongue Body gesture. However, as this gesture appears to extend itself into the characterisation of consonants (Browman and Goldstein 1992a:158, Figure 2), this specification appears to be irrelevant to the stop v. vowel contrast. (In later stages, when more contrasts are established in the child's system, the specification of the Tongue Body gesture only might provide a unique specification.)

The opposition between oral and nasal stop is described by the Velum gesture. Nasals are uniquely specified with a [wide] label for this gesture (7ii.). For the oral stop v. continuant contrast, the presence v. absence of a complete constriction is relevant, which is characterised by the constriction degree tract variable of the oral gestures. Continuants are not [close]: \*[close] or [critical/narrow/mid/wide] for *the oral gestures* (7iii.). In terms of gestural scores, the oppositions are thus specified as follows:

- (7) i. close for Lips, Tongue Tip and Tongue Body v. Ø
- ii. close for Lips, Tongue Tip and Tongue Body v. wide for Glottis
- iii. close for Lips, Tongue Tip and Tongue Body v. critical/narrow/mid/wide for Lips, Tongue Tip and Tongue Body

This characterisation of the contrasts in the child's early system appears flawed. The descriptor for the tract variable, namely, constriction degree, of a gesture is distinctive and not the gesture itself, whilst the constriction degree is regarded as an inherent part of the gesture, and is not granted independent existence in the gestural score. The claim made by the characterisation in (7) is thus not a transparent one as it refers to constriction degree independent of the gestures. Also, there is no way to representationally generalise the oral gestures (Lips, Tongue Tip and Tongue Body). The description of the child's first contrasts in terms of articulatory phonology is thus concluded to lack uniformness and insight.

The idea that the first differentiation, consonant *v.* vowel, is paramount in the onset of the child's phonological system is embraced:

... the canonical syllable [is] the first step toward differentiation of two major classes of oral gesture: vocalic and consonantal. ... we do not find a child ... making the mistake of replacing a narrow/mid/wide vocalic gesture with a closed/critical consonantal gesture, or vice versa. No doubt such errors are blocked by the biophysical structure of the syllable, that is, by its alternating pattern of opening and closing the mouth (Studdert-Kennedy and Goodell 1995:83).

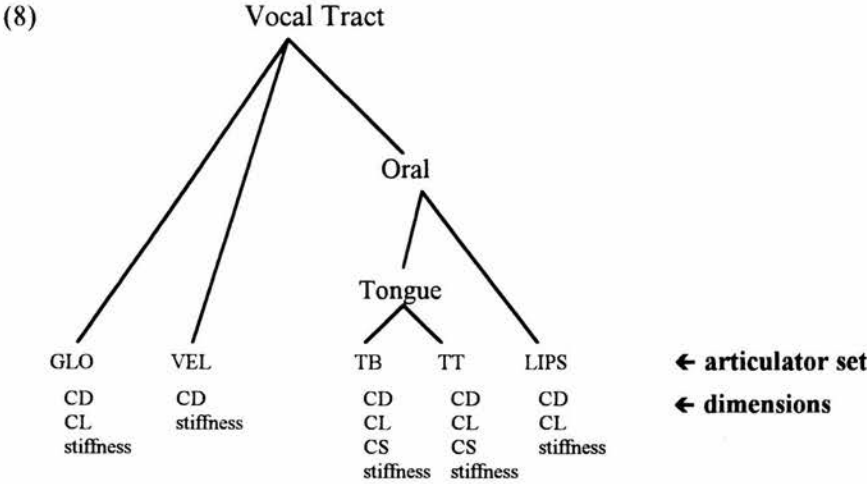
However, the gestural representation in articulatory phonology does not offer any means to capture this first step in terms of a basic notational distinction.

### 6.3.2 *Tube geometry*

Browman and Goldstein (1989) discuss the relation between the gestural notation proposed for articulatory phonology (6.1) and feature geometry (see 1.3 and 3.). They claim that the gesture and the concept of gestural score could 'usefully be incorporated into feature geometry' (1989:222). The most outstanding difference between these two notational models is the characteristic of the gesture that it expresses both constriction location and constriction degree. This discrepancy is ironed out in the proposal of tube geometry, a type of feature geometry that incorporates a novel way of expressing manner of articulation or constriction degree (1989:221-22). As the early contrasts of the child's phonology involve entities that are defined with reference to manner of articulation, a closer inquiry into the merits of tube geometry in relation to early phonological acquisition is required.



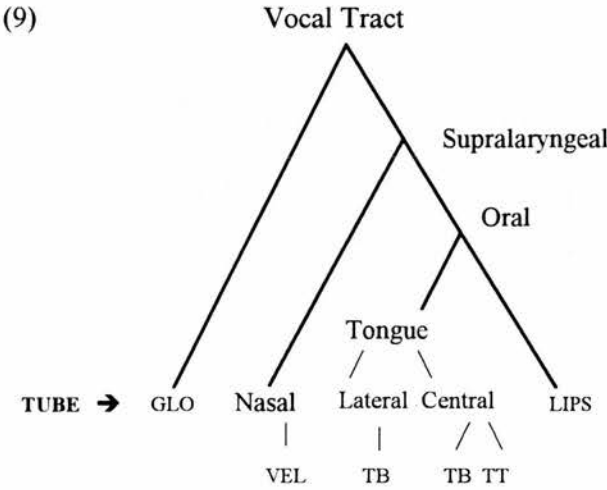
In tube geometry, the vocal tract is regarded as a set of tubes, connected in series or in parallel, rather than as a set of articulators. The articulators are assumed to be present within these tubes and to achieve constrictions. Gestures can be active simultaneously. '[The] gestures interact to determine the overall aerodynamic and acoustic output of the entire linked set of tubes' (1989:235). The top node in the tube geometry is labelled Vocal Tract, and the gestural descriptors are at the terminal nodes (constriction degree (CD), constriction location (CL), constriction shape (CS) and stiffness), each establishing a separate dimension for the gesture they describe. The gestures are represented as nodes superordinate to the descriptors. Groupings of gestures are implemented in the hierarchy to reflect articulatory independence of the articulators, which is thus stipulated by the anatomy of the vocal tract (1989:223-24). The resulting articulatory hierarchy is presented below (1989:223, Figure 8).



Of main interest here, in relation to the child's first phonological contrasts, is the representation of constriction degree. Different from proposals concerning feature hierarchies, constriction degree (CD) is not specified directly under the highest node (cf. the location of [stricture], [continuant] and [sonorant] under the Supralaryngeal or Root node (1989:227); see 3.2). Rather, as an attribute of a gesture, it is associated with the articulator node (1989:230-31).

The important point here for phonology is that, in the output system, CD exists simultaneously at all the nodes in the vocal tract hierarchy - it is not isolable to any single node, but rather forms its own CD hierarchy (1989:235).

The constriction degree at each level in the hierarchy defines a natural class (1989:239). This will be discussed in more detail below. First, the tube geometry is presented here (1989:236, Figure 13).



Note that the tube hierarchy includes a Supralaryngeal node, unlike the articulatory hierarchy presented in (9); the former is important in the description of the output of the vocal tract, whereas the latter is reflecting the input. ‘[U]sing the criterion of articulatory independence, [there is] no anatomical reason to combine any of the three major subsystems [i.e. oral, velum and glottal system] into a higher node in the input hierarchy’ (1989:224). The differentiation between input and output is discussed as follows (1989:222):

The articulatory explicitness of the gestural approach leads to a clear-cut distinction between features of input and features of output. That is, a feature such as “sonority” has very little to do with articulation, and a great deal to do with acoustics ... This difference can be captured by contrasting the *input* to the speech production mechanism - the individual gestures in the lexical entry - and the *output* - the articulatory, aerodynamic and acoustic consequences of combining several gestures in different parts of the vocal tract.

This distinction between input and output features in tube geometry could offer a more workable model for phonological acquisition with regard to the input to the child’s production/perception model. The strictly articulatory-based input of articulatory phonology appears to be inappropriate for the child as a language learner that had not yet acquired a full phonological system (see 6.2.1). To attribute acoustics to the result of speech production creates possibilities for a more appealing model. However, the acoustic characteristics in the description of the output are not valid when

this signal functions as input. Here too, input is strictly in terms of articulators, as becomes clear from the quotation above.<sup>7</sup> So, tube geometry, in this context, does not offer a more insightful representation in terms of the nature of the child's input.

The tube geometry presented in (9) above reflects the structure of the proposed system of tubes or airflow channels and their terminators that represents the vocal tract. Basically, the vocal tract is the main airflow channel that is terminated by the Glottis gesture at one end, and the lips gesture at the other. A nasal tube branches from the main tube and is terminated by the Velum gesture. Parallel to the main tube, between the nasal tube and the lips, there is a lateral tongue channel, represented in the tree with a terminal Tongue Body node. The lateral tube and the main tube come together to be terminated by the lips. The main tube, with the parallel lateral tube and branching-off nasal tube, is the central tongue channel, which has both a Tongue Tip node and a Tongue Body node in the tube geometry. These nodes, represented at the lowest level of the hierarchy, reflect the constrictions made by the articulators. Constriction degree is present at all levels of the tube geometry. The physical source of the constriction degree is at the terminal nodes, though. For higher nodes, constriction degree (CD) is determined by means of the percolation principles proposed:

Within each of [the] basic tubes, the CD will be determined by the CD of the gestures acting within that tube, which are shown as subordinates to the tube nodes (1989:236).

The effective CD at each superordinate node can be predicted from the CD of the tubes being joined and the way they are joined. When tubes are joined in parallel, the effective CD of the compound tube has the CD of the *widest* component tube, that is, the maximum CD. When they are joined in series, the compound tube has the CD of the *narrowest* compound tube, that is, the minimum CD. ... The percolation principles follow from aerodynamic considerations. Basically, airflow through a tube system will follow the path of least resistance ... (1989:237).

So, the constriction degree at lower levels of the tube geometry determines the constriction degree for nodes higher up the hierarchy.<sup>8</sup> A superordinate node will in this way be characterised by a

<sup>7</sup> This offers an interesting picture for the child's auditory feedback loop (Cf. Vihman 1991). Contrary to common sense expectations, the child's production is (partially) regarded in terms of acoustics, and when this output functions as input, it is regarded as purely articulatory. This scenario appears to take the hearer/discussion partner's point of view, rather than the speaker's, into account when describing the speaker's phonological competence.

<sup>8</sup> In order to determine the constriction degree at superordinate levels, see Browman and Goldstein (1989:237), in particular Table II.

constriction degree, ‘regardless of whether some gesture is actively producing the constriction’ (1989:239).

The constriction degree hierarchy, discussed above, expresses natural classes (1989:239-41) and phonological alternations (1989:241-45). Unlike featural notational systems, tube geometry does not require a separate name for each natural class, and does not lack a principled representation of the hierarchical relation among natural classes. Instead, ‘[a]ll the levels of the CD hierarchy appear to be useful for establishing natural classes, and for relating the CD natural classes to one another’ (1989:241).

Below the schematically presented tube hierarchies for /a l n d/ are given (10IIa.-d.). As indicated in the diagram in (10I), the different nodes are indicated in separate boxes, reflecting the constriction hierarchy presented. The constriction degree for each node is represented by squares: ■ indicates constriction degree [closed], ▣ indicates [critical] and □ indicates [open] (1989:240). The levels in the constriction hierarchy are indicated to the left of the diagram; from top to bottom: Vocal Tract, Supralaryngeal, Oral, Tongue, Tube and Gestural. The boxes that are shaded are irrelevant; they do not represent nodes in the tube hierarchy.

(10) I

VOC					voc
SUP					sup
ORAL					oral
TNG			tongue		
TUBE	GLO	nas	lat	cen	LIPS
GEST		VEL	TB	TT TB	

II

VOC					□
SUP					□
ORAL					□
TNG				□	
TUBE	▣	■	□	□	□
GEST				□	

a) vowel /a/

VOC					□
SUP					□
ORAL					□
TNG				□	
TUBE	▣	■	□	■	□
GEST			□		■

b) lateral /l/

VOC					□
SUP					□
ORAL					■
TNG				■	
TUBE	□	□	■	■	
GEST		□		■	

c) nasal /n/

VOC					■
SUP					■
ORAL					■
TNG				■	
TUBE	□	■	■	■	□
GEST				■	

d) oral stop /d/

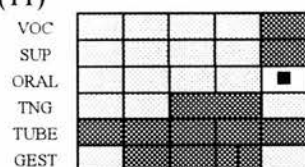
To determine natural classes, the different levels (horizontally in the diagrams here) are relevant. For instance, it becomes clear from (10IIa.-c.) that what /a/, /l/ and /n/, respectively, have in common is the characterisation for constriction degree at the Vocal Tract and Supralaryngeal level, which is [open] for both nodes. ‘This aspect of the CD hierarchy thus defines a phonological natural class consisting of nasals, laterals and vowels’ (1989:240). Similarly, nasals and stops form a natural class; they both have a [close] specification for the node at the Oral level. Nasals also form a natural class on their own. This becomes clear from their unique specification at the Tube and Gestural level; both these constriction degrees are specified [open]. In this way, the nodes at the different levels of the tube geometry hierarchy define natural classes (1989:240-41).

In order to relate this representation of natural classes to the first oppositions in the child’s system, the method of specifying the nodes for constriction degree needs to be considered again. The assumption is that at the time of the opposition oral stop v. nasal stop, the realisation of place of articulation is not relevant, e.g. labial v. alveolar. What is relevant is the absence v. presence of nasality. However, the constriction degree specifications of the articulator node (Lips v. Tongue Tip, respectively), which are at the bottom of the hierarchy, are the determining factor for the specification of superordinate nodes. This makes it impossible not to take into account the Lips and Tongue articulators, from which the natural classes classification is deduced.

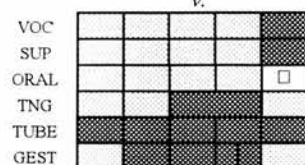
One could assume, however, that the child only has a limited structure, and as he does not make a distinction phonologically between the different places of articulation, his phonological system does not have the corresponding structure. (For the sake of the argument here, I ignore the subsequent discrepancy between child and adult language, namely that the articulators determine the constriction degree specifications at superordinate nodes, according to the tube geometry proposal.) This would mean that for the opposition nasal v. oral stop (6ii.), the Oral constriction

node is specified as [close] and the Velum constriction degree is [open] for the nasal stop and [close] for the oral stop. It is then also assumed that before this opposition, nasal and oral stops together formed a contrastive unit, the specification of which only takes the Oral constriction into account. The oppositions stop v. vowel, nasal stop v. oral stop, and oral stop v. continuant (6i.-iii.) would then look as follows (where the left member of the opposition is presented in the higher diagram; those parts of the hierarchical structure that are not yet acquired are absent, and the corresponding boxes are shaded dark.):

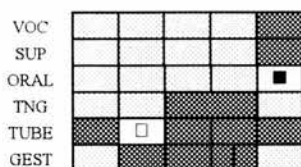
(11)



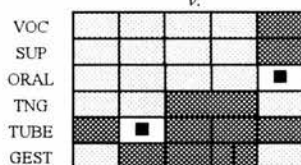
v.



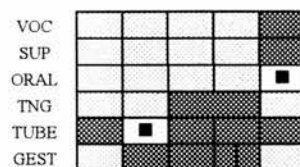
a) stop v. vowel



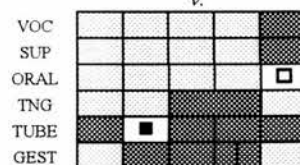
v.



b) nasal stop v. oral stop



v.



c) oral stop v. continuant

According to this tube geometry scenario, the child is assumed to start building his phonological representation in the middle of the resulting (adult) hierarchy. As a consequence, intermediate nodes need to be inserted at a later stage, e.g. the constriction degree specification at the Tongue level. This is regarded as undesirable from a hierarchical geometry point of view, as it allows for non-universal geometries to come into existence. This is in conflict with one of the basic assumptions of hierarchical representation that the organisation of nodes is universally organised (cf. 3., Figure 1). Also, because this representation is simultaneously the child's phonological representation and his phonetic description, information is missing that is crucial in the acquisition of new contrasts. If (phonetic) place information of unstable realisations is not available to the child, he lacks the information to master new (phonological) place contrasts. So, from a phonetic point of view, the specifications at the lower levels need to be implemented.

Thus, the collapse of phonetics and phonology prevents the abstraction of the phonetic description in order to arrive at a phonological representation; the absence of the articulator nodes in the tube hierarchy is required for the phonological representation, in order to arrive at a sparse enough representation to reflect the early oppositions. At the same time, the presence of the articulator



nodes is required from a learner's point of view, in order to provide the child with sufficient phonetic information. The assumption of a single representation for phonetics and phonology renders tube geometry equally unsuitable for the description of the early acquisition of phonology, in relation to articulatory phonology. (This assumption appears to be maintained despite the distinction that is made between 'features of input and features of output' (1989:222; see above).)

#### 6.4 Conclusion

The proposals of both articulatory phonology (Browman and Goldstein 1986, 1989, 1992a) (6.1) and tube geometry (Browman and Goldstein 1989) (6.3.2) have been outlined, and subsequently discussed with regard to the description of the child's early contrasts (6.3.1 and 6.3.2, respectively). Also, the discussion in Studdert-Kennedy and Goodell (1995) concerning child language in the context of the gestural notation of articulatory phonology has been reviewed.

Gestures are proposed as a more suitable means of description of pre-linguistic and early linguistic development than features, as the former offer direct indications of the movement and timing of the articulators. It is argued that the child is better served with an observable, physical representation of his speech in articulatory terms. However, auditory feedback is considered to be essential for the child's speech development (Vihman 1991), and an articulatory representation as such can not help a child acquire perception and production skills (6.2.1). Note that the expression of sonority in this phonological representation, which has been concluded to be the underlying, auditory notion of the initial contrasts (II3.), is ruled out *a priori*. Also, the collapse of phonetics and phonology in one representation - the gesture - and the subsequent single lexicon appear to call for a discussion of the assumed model of production/perception of the child. To reflect the child's production and perception process, two separate components have been proposed (Vihman 1991, Studdert-Kennedy 1991). This issue is not addressed in Studdert-Kennedy and Goodell (1995), though (6.2.2). Finally the use of gestures in the description of the child's early words, by means of a gestural score, fails to make a distinction between variable and stable forms, nor does it offer an useful representation of non-adjacent assimilation, i.e. consonant harmony. The articulatory phonology representation does not allow for a sparse representation. Timing errors and context-sensitive assimilation, i.e. overlap of gestures, are discussed. However, these do not insightfully address the issues of variability and consonant harmony (6.2.3).



The interdependence between constriction degree and the articulator, a trademark of articulatory phonology, gives rise to an opaque characterisation of the child's early phonological oppositions (6.3.1). The representation of constriction degree within tube geometry is problematic in relation to the child's overall speech development; what is required phonetically is rejected phonologically in the representation, and what is required phonologically disables the child's development as it does not provide enough phonetical information (where phonology reflects stable, mastered contrasts, and phonetics reflects also the variable forms) (6.3.2). On the whole, the unity of phonetic and phonological representation that is advocated in articulatory phonology and tube geometry, and the unseparable representation of constriction degree and articulator are concluded to be unsuitable for an insightful description of early phonological acquisition.

## 7. Place representation and acquisition data

From the discussion of the notational models in 2.-6. and the way in which they represent the early stages of phonological development, it has become clear that the specification for place of articulation in acquisition is unstraightforward in most models. In terms of binary features, labial can not be identified by means of a single feature. The characterisation [+grave, –compact] would also include velar and alveolar segments on the basis of the [grave] and [compact] features, respectively (2.). The feature geometry proposal is by definition restricted by the monotonicity principle. This gives rise to the specification of rather general nodes, e.g. Place for labial, which is not insightful (3.). With regard to the geometry notation, note that the failure to offer a clear acquisitional representation is mainly due to the hierarchical geometry structure rather than to the actual place features adopted. Moreover, the articulator-based model (labial, coronal, dorsal) is specifically claimed to be suitable for the description of the early realisation of place, namely as part of the VC harmony proposal in Levelt (1994) (II2.). Dependency phonology appears to offer an insightful place specification. Labial is uniquely presented by a unary place feature (4.). The radical CV phonology proposal discusses the non-specification of velar and, more generally, place specification that is based on system-internal logic, assigning a marked specification to labial, for instance. The predictions made by this model do not seem to agree with the data observations (5.). Finally, the articulatory phonology notation appears not to be able to describe the acquisition contrasts particularly appropriately. It is not essentially the choice of gestures that renders the articulatory notation opaque. The collapse of phonetics and phonology in representation, and the adoption of the gesture as the basic unit of representation do not result in an insightful account of place assimilation processes during early acquisition. Tube geometry encounters similar problems to feature geometries with regard to the hierarchical architecture of the notation (6.).

7.1-3 presents a detailed inquiry into the adequacy of the place specification in dependency phonology and the articulator-based model; for the other models, the place representation (binary features, radical CV phonology) or the overall design of the model (articulatory phonology) has been concluded to be less or un-suitable for the description of the acquisition process. The ability of these two models to express the early stages of acquisition and the validity of the predictions they make regarding place development will be assessed on the basis of acquisition data (7.2). At the same time, the VC harmony claim is investigated. Note that the realisation of place in the

ChildPhon data has also been discussed in the context of underspecification (II4.) and place assimilation processes (II5.).

## 7.1 Theory

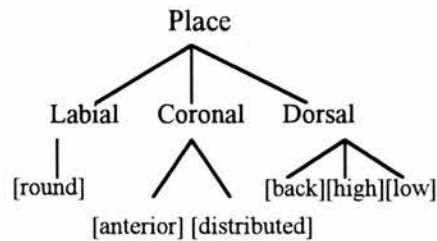
Early place acquisition is concerned with the three main places of articulation; labial, alveolar and velar. Realisationally, these include “finer” place distinctions that can be regarded as free realisations of these three (or less) place entities (non-contrastive variability). The representation of these three places of articulation in the feature geometry framework is discussed in 7.1.1. Subsequently, dependency phonology and place specification are considered (7.1.2).

### 7.1.1 Feature geometry: labial, coronal and dorsal

#### 7.1.1.1 Adult models

The geometry tree in Sagey (1986) has the following place node structure (Figure 3, 3.1):

(1)



The labial, coronal and dorsal nodes are employed for the specification of both consonants and vowels. However, the dependent features [round], [back], [high] and [low] only describe vowels (and glides). [round] is produced by the lips, and the dorsal-dependent features by the tongue-body. Coronal characterises retroflex vowels, and is usually non-distinctive for vowels (Clements and Hume 1995:275).<sup>1</sup>

The idea that consonants and vowels are characterised by the same set of features has been applied more extensively in the feature geometry in Clements (1991). Labial, coronal and dorsal are all regarded as dependents of the place node (similar to the geometry in Sagey 1986), characterising both consonants and vowels. These features themselves do not have dependent structure. The vowel feature [back] is replaced by [dorsal], and [round] by [labial], relinquishing

<sup>1</sup> I use “vowels” where Clements and Hume (1995:275, 277) use “vocoids”, thus regarding glides as being included in the class of consonants.

the description in terms of articulatory movement. The assumption that place of articulation in vowels and consonants is represented by the same set of features can be expressed by an articulator-based description of place (Clements and Hume 1995:275). So, although consonantal constriction of, for instance, labial consonants and rounding of vowels 'have a different phonetic expression because of the differing stricture properties of consonants and vowels, ... they are [regarded as] fundamentally the same set of categories' under a labial-coronal-dorsal approach (Kenstowicz 1994:462-63). The same is true for the coronal and dorsal consonant-vowel relation. The place features in Clements (1991) express the following:

(2)	<u>place</u>	<u>consonantal expression</u>	<u>vocalic expression</u>
	<i>labial</i>	lip constriction	rounding
	<i>coronal</i>	constriction of tip/blade/front of tongue	front and retroflex
	<i>dorsal</i>	constriction at back of tongue	back

As a consequence of this feature set, the following natural classes emerge: labial consonants and rounded or labialised vowels; coronal consonants and front vowels; and dorsal consonants and back vowels (Clements and Hume 1995:277).

#### 7.1.1.2 Vowel-consonant interaction in phonological acquisition

The three consonant-vowel relations (labial, coronal, dorsal) that are adopted by the type of proposal discussed in 7.1.1 are the basis for the acquisition proposal in Levelt (1994). These three relations have been argued to be of considerable relevance to the (consonant) output of the child in the early stages of phonological acquisition. Levelt (1994) rejects consonant harmony as the explanation of the observation that place of articulation is often the same across the individual child's realisations (see discussion of this proposal in II2.). Rather, the interaction between vowels and consonants in the underlying representation, i.e. vowel-consonant (VC) harmony, is held responsible for the constancy of place in the child's utterance. (For a critical discussion of this VC harmony account, see II2.3.1.) The foundation of the VC harmony proposal is the (universal) relation between round vowels and labial consonants, front vowels and coronal consonants, and back vowels and dorsal consonants, which is also expressed by the articulator model (see 7.1.1.1).<sup>2</sup> This is illustrated by the following example from acquisition data: *schoen* 'shoe' /sχun/

<sup>2</sup> Note, however, that Levelt (1994) dismisses the dependent features of the labial, coronal and dorsal nodes (see II2.1.2 and II2.3.2.2).

[pum] (1994:47). The assimilation to labial of a consonant in a target word that does not have a labial consonant and that does have a labial vowel is interpreted as support for the role of the vowel as source of place assimilation.

7.1.2 *Unary components and place*

In dependency phonology (Anderson and Ewen 1987), place of articulation is expressed by means of unary components that occur on their own or in combination. The way in which (place) components combine is expressed by means of dependency relations (e.g. unilaterally and mutually dependent) (see 4.2-3).

The component [u] represents the characteristic grave, i.e. a predominance of the lower side of the spectrum. It is not only labial and velar consonants that are considered grave; round vowels are also represented by this component (1987:233-34, 237). Sounds that are produced with the tongue blade or body as active articulator are considered to be lingual, represented by [l]. The lingual feature is adapted from Lass (1976); ‘horizontally speaking, all prefrontals and postvelars are [-ling], and dentals, palatals and velars are [+ling] (as are high vowels ...)’ (1976:187-88). [a] represents low vowels and [i] high vowels, reflecting acuteness, and compactness or sonority, respectively. These two components also play a role in the characterisation of consonants; [a] is included in the representation of uvulars and pharyngeals (Anderson and Ewen 1987:243), [i] indicates palatality (1987:238). The main major classes of place of articulation and their dependency characterisation are given in (3).

(3)	[u]	[l]	[u,l]	[a]	[i]
	labial consonants round vowels	alveolar consonants	velar consonants	low vowels	high vowels

This notation expresses the following natural classes, amongst others: labial and velar consonants and round vowels, as they all have a grave component; and also, alveolar and velar consonants, characterised by [l] for linguality.

7.2 **Acquisition data**

7.2.1 *The realisation of consonants; VC harmony?*

According to the VC harmony proposal in Levelt (1994), the articulator-based model (labial/coronal/dorsal) adequately describes the realisation of consonants in the child’s output.

This claim is investigated here as part of the concern central to this study, the representation of consonants in early acquisition. Namely, all consonantal realisations of each child (see below) have been considered. Those child realisations that are different from the adult target with respect to place of articulation, and that do not involve a consonant cluster are taken into account.

In the absence of a consonant that can function as the source segment for place assimilation (or a homogeneous consonant+vowel or vowel+consonant sequence), the vowel is, in first instance, assumed to be solely responsible for the place realisation of the consonant considered. If no such consonant or appropriate vowel, in terms of place of articulation, is present, the "harmony" consonant is concluded to have no source in particular. These *no source* and *vowel* cases observed in the child's spontaneous utterances form the core material of the discussion here. The consonants and vowels in Dutch are presented here again for convenience, according to the labial/coronal/dorsal classification (Levelt 1994:80).

(4)	Labial	round vowels	/y ø u u o ɔ œy /
		labial consonants	/p b f v m v /
	Coronal	front vowels	/i e ε ɪ y ø u ei œy /
		coronal consonants	/t d s z n j l /
	Dorsal	back vowels	/u o ɔ a ɑ au /
		dorsal consonants	/k χ x ŋ R /

The output of four children (Robin 2, Eva 4, Tom 7 and Elke 9) has been considered in detail. Jarmo's data (8) has not been taken into consideration here as the t-pattern in his data is considered to interfere directly with the vowel-consonant interaction that is investigated (see II8.).

Tom (7) and, to a lesser extent, Elke (9) have forms in their output with a final [w] following a round vowel as the realisation of a target form with a vowel-final round vowel. Examples are:

(5)	a.	<i>auto</i>	'car'	/oto/	[ʔɔtow]	7	#11
	b.	<i>zo</i>	'so'	/zo/	[sow]	7	#22
	c.	<i>au daar</i>	'autch!'	/au/	[ʔauw]	7	#18
	d.	<i>is die vies</i> <i>nou</i>	'now'	/nau/	[nauw]	9	#18

As the final consonant in the child's form (5a.-d.) does not correspond to a final target consonant, these cases are not regarded as instances of harmony proper. Rather, they illustrate an individual

tendency in the children's output that does not feature in the output of other children. At the same time, it reflects the interaction between round vowels and labial consonants.

What follows is a discussion of the claim that back vowels interact with dorsal consonants, high vowels with coronal consonants and round vowels with labial consonants. These three vowel-consonant relations have been claimed to be responsible for the harmony cases in the child's output (Levelt 1994).

The discussion of the VC harmony cases will consider high and round vowels in particular (coronal VC harmony 7.2.1.1, labial harmony 7.2.1.2, and exceptions to VC harmony predictions 7.2.2). Back vowels appear to present an opaque class representationally in Levelt (1994) regarding vowel-consonant interaction. Namely, back vowels, including both back and low vowels (see classification in (4)) are claimed to interact with dorsal consonants. Back vowels that are round are initially specified for labial only. Low vowels (non-round) are regarded as back vowels, but they are specified for dorsal only after the presence of dorsal consonants in the data (1994:81). This appears to be an illogical claim as VC harmony would offer the possibility of the emergence of a dorsal consonant in a child's realisation on the basis of the presence of a back or low vowel, i.e. a dorsal vowel, independent of the presence of a dorsal consonant in the data. (For the discussion on the characterisation of low vowels and other notational aspects, see II.2.)

### 7.2.1.1 Coronal VC harmony<sup>3</sup>

(6)	I					
a.	<i>kijk</i>	'look'	/keik/	[tɛ:i 'tɛik' 'tɛik]	2	#6-14.17
b.	<i>kikker</i>	'frog'	/kikə/	[tɪ,kə 'tɪkə 'tɪk'ər]	2	#12-18
c.	<i>de keuken</i> <i>opruimen</i>	'to tidy kitchen'	/køkən 'ɔp,rœymə/	[tɛ:kø:pə'mə]	2	#14
d.	<i>nog kijken</i>	'to look'	/keikə/	[tɛ:kə]	2	#15
e.	<i>ik even kijken</i>	'to look'	/keikə/	[t'ɛikə]	2	#16
f.	<i>ik honkballen</i> <i>kijken</i>	'to watch'	<i>idem</i>	[tɛikə]	2	#17
g.	<i>geen mes</i>	'not any'	/χen/	[s <sup>w</sup> e]	2	#23

<sup>3</sup> (6II) presents all the phrases from Eva (4) that start with *kijk* 'look', e.g. *kijk eens* 'look then' #6-8, *kijk die* 'look that one' #5. In the other data sets, only the *kijk* phrase will be included if they display the same relation between target and realisation regarding the consonants.



## II

a.	weg	'gone'	/vex/	[d̥ɪχ 'dɛχ 'jɛ'χ 'd'ɛχ 'dæχ 'dɪχ]	4 #1-3
b.	kijk	'look'	/keik/	[tɛj't 'tɛit 'tɛ:it 'tɛit]	4 #2-6
c.	kijken	'to look'	/keikə/	[tɛitə]	4 #2-9
d.	tekenen	'to draw'	/tekənə/	[tɛ:tɛ]	4 #3
e.	die <u>kijk</u> die	'look'	/keik/	[tɛ'i]	4 #4
f.	zitten	idem	idem	[ɛtɛit]	4 #4
	mamma <u>kijk</u>				
g.	oma <u>kijken</u>	'to look'	/keikə/	[tɛitə: 'tɛit'ə:]	4 #4-6
h.	<u>kijk</u> die	'look'	/keik/	[tɛi:]	4 #5
i.	poes <u>kijken</u>	'to look'	/keikə/	[tæitə 'tɛitə]	4 #5
j.	papagaai	'parrot'	/papa'χai/	[tæ:i]	4 #5
k.	daar <u>kijken</u>	'to look'	/keikə/	[tɛitə:]	4 #5
l.	<u>ikke</u> doen	'I', emphatic	/kə/	[ʔitə 'ʔitə]	4 #5-6
m.	<u>kijk eens</u>	'look then'	/kei:kəns/	[tɛi:tɪs 'tɛi:təʃ 'tɛi:tɪs 'tɪ: 'tɪ:s]	4 #6-8
n.	leeuw <u>kijken</u>	'to look'	/keikə/	[tæit]	4 #7
o.	leeuw <u>kijken</u>	idem	idem	[tɛitə]	4 #7
	wil				
p.	kijk maar	'look then'	/keik 'maɪ/	[tɛi'ma' 'xɛi'ma'ɪ]	4 #8
q.	<u>kijk</u> nou eens	'look'	/keik/	[tɛi]	4 #9
r.	<u>kijk</u> nou	idem	idem	[gɛik]	4 #10
s.	gele	'yellow'	/χelə/	[ʃɛ:lə]	4 #10

## III

a.	kuiken	'chick'	/kœykə/	[tœkə]	7 #11
b.	geit	'goat'	/χɛit/	[tɪ 'tɛ 'lɑiʃ]	7 #11-13
c.	kikker	'frog'	/kɪkəɪ/	[tɪtə]	7 #14
d.	poten <u>pakken</u>	'to grab'	/pəkən/	[pɑtɪ]	7 #21
	dan				

## IV

a.	huis	'house'	/fiœys/	[ʃi]	9 #7
b.	kikker	'frog'	/kɪkəɪ/	[tɪtə 'tɪt]	9 #9
c.	kip	'chicken'	/kɪp/	[ʔɪt]	9 #9
d.	kijk	'look'	/keik/	[tɛk]	9 #14
e.	weg	'gone'	/vex/	[lɛχ]	9 #14

The harmony examples in (6) are the instances of coronal vowel-consonant interaction in the data of the four children considered. The presence of a high vowel is assumed to be the decisive factor for the realisation of a coronal consonant in the place of a non-coronal target. Note that the actual

number of coronal harmony cases is limited. It affects 4, 6, 4 and 5 lexical items in the four data sets (6I-IV) (for child no. 2, 4, 7 and 9, respectively).

The forms of the different children appear to have a different status; whereas they represent an apparently systematic group of realisations for Robin (2) and Eva (4), the coronal harmony cases in the data of Tom (7) and Elke (9) are mainly first instances (*kuiken, geit, een muis in zijn bekje, poten pakken* dan 7; *kikker, weg, huis* 9) and exceptional forms. This is illustrated by the examples in (7) (exceptions are presented in bold typescript). The instances of *kijk* 'look' of Eva (4) and Elke (9) are compared (7a.), as well as the realisation of *kikker* 'frog' of Robin (2) and Elke (9) (7b.). (Cf. the realisations of *kikker* by Tom (7), 14 in total in #11-13, which include one exception: [tita] #14.)

(7) a. <i>kijk</i> 'look' /kɛik/		b. <i>kikker</i> 'frog' /kɪkəɪ/	
4	9	2	9
#2 [tɛjɪt 'teit]	#2 [ʔəkeik]	#6 [kʊɾxə]	#9 ['tɪtʉ 'fɪp 'tɪt]
#4 [tɛit 'tɛit]	#11 [kaik]	#12 [tɪkə]	#13 [kɪkə 'keikə]
#6 [tɛit]	#14 [keik 'tɛk 'keik]	#15 [tɪkəɪ]	#15 [kɪkə 'kɪkə]
	#15 [kɪk 'keik 'kɛk]	#18 [tɪk'əɪ]	'kɪkə]
	#16 [keik 'keik 'kaik]		#16 [kɪkə]
	#17 [keik]		
	#18 [keiç]		
	#19 [keik]		

Another generalisation that emerges from the coronal VC harmony examples in (6) is the relation between [t] and velar target consonants. In all but three cases, [t] (or alveolar consonant) is realised in the place of a target consonant that is velar. (The realisation of *huis* 'house' 9 is not taken into account, as it is assumed not to involve a place specification in the initial target consonant.) The three remaining cases are *weg* 'gone' 4, *weg* 'gone' 9 and *kip* 'chicken' 9. The forms from Elke (9) have been concluded to be part of a data set that is not considered to constitute a regular tendency or development. The realisation of *weg* 'gone' 4 is thus the only exception. It has a labial target consonant that is realised as [t] in the presence of a front vowel (see 7.2.3.3).

Moreover, the coronal VC harmony forms in (6) occur at a time when the phonological contrasts in the children's systems do not (yet) comprise a stable three-way place contrast. The harmony forms are realised in sessions during which coronal is assumed to be not specified (II3.).

Exceptions to this generalisation are *poten pakken* dan #20 (7) and *geen mes* #23 (2). Again, these realisation do not seem to reflect a regular development.

### 7.2.1.2 Labial VC harmony

<b>(8) I</b>						
a.	<i>koe</i>	'cow'	/ku/	[pu 'pu:]	2	#6,7
b.	<i>goed</i>	'good'	/χut/	[fut']	2	#18
<b>II</b>						
a.	<i>klok</i>	'clock'	/klɔk/	[pɔʔt 'pɔ:tə 'pɔt]	4	#3-4, 8
b.	<i>oma toe</i>	'to'	/tu/	[pu:]	4	#4
c.	<i>panda doen</i>	'do'	/dun/	[bu]	4	#4
d.	<i>woef ook</i>	'also'	/ok/	[o:t]	4	#4
e.	<i>kachel</i>	'heater'	/kaxəl/	[tə'χ'o:m]	4	#5
<b>III</b>						
a.	<i>uit</i>	'out'	/œyt/	[ʔauf 'hœyɸ 'ʔœyɸ 'haʊ]	7	#6
b.	<i>koe</i>	'cow'	/ku/	[ʔβu 'βu: 'pɥ 'vu: 'buχɛkə]	7	#8-15
c.	<i>klok</i>	'clock'	/klɔk/	[kəp 'kəp]	7	#12
d.	<i>uil</i>	'owl'	/œyl/	[ʔauw 'ʔäuw 'ʔauw 'ʔauɸ 'ʔauw]	7	#12-16
e.	<i>ezel</i>	'donkey'	/ezəl/	[ʔr'sow 'kɪsɔv]	7	#13-15
f.	<i>neus</i>	'nose'	/nøs/	[nøf]	7	#17
g.	<i>de spiegel</i>	'mirror'	/spɪχəl/	[pɪχow]	7	#25
<b>IV</b>						
a.	<i>huisje</i>	'house', dim.	/hœyʃə/	[bo:s:ʃə]	9	#2
b.	<i>koe</i>	'cow'	/ku/	[pu]	9	#4
c.	<i>koek</i>	'biscuit'	/kuk/	[buk 'puk 'pukə]	9	#6
d.	<i>stoel</i>	'chair'	/stul/	[tuw]	9	#11
e.	<i>uil</i>	'owl'	/œyl/	[ʔœyɥ 'ʔauw]	9	#17-18
f.	<i>ballon</i>	'balloon'	/bɔ'lɔn/	[lɔm]	9	#19
g.	<i>ballonnen</i>	'balloons'	/bɔ'lɔnən/	[lɔmə]	9	#19

The data sets in (8I-IV) present the labial VC harmony cases in the data of Robin, Eva, Tom and Elke (2, 4, 7 and 9). There are 17 forms (16 lexical items). (The realisation of *huisje* 'house', dim. (9) is not regarded as a harmony form proper as the target is not specified for place.) Of these 17 labial realisations with a round vowel, seven have a velar target consonant and nine have an alveolar target consonant. Relating these forms to the development of contrasts in the phonological system and comparing them to the coronal VC harmony group (7.2.1.1), a more varied picture emerges with regard to the place contrasts present at the time of utterance. Whereas coronal

harmony occurs at a time when the opposition for place is absent or labial v. non-labial, the temporal distribution of labial harmony cases is perhaps somewhat more diverse, as illustrated below (cf. 7.2.1.1).

(9)

place specification: Ø			labial v. Ø		labial v. alveolar v. velar	
<b>I</b>			#6,7	<i>koe</i>		
			#18	<i>goed</i>		
<b>II</b>	#3	<i>klok</i>	#4,8	<i>klok</i>		
			#4	<i>oma <u>toe</u></i>		
			#4	<i>panda <u>doen</u></i>		
			#4	<i>woefook</i>		
			#5	<i>kachel</i>		
<b>III</b>	#6	<i>uit</i>				
	#8-11	<i>koe</i>	#12-15	<i>koe</i>		
			#12	<i>klok</i>		
			#13	<i>ezel</i>		
			#12-15	<i>uil</i>	#16	<i>uil</i>
					#17	<i>neus</i>
<b>IV</b>	#4	<i>koe</i>			#25	<i>de <u>spiegel</u></i>
	#6	<i>koek</i>				
			#11	<i>stoel</i>		
			#17	<i>uil</i>	#18	<i>uil</i>
					#19	<i>ballon</i>
					#19	<i>balonnen</i>

As also observed for the coronal VC harmony forms, the total number of VC harmony cases is rather small. This statement holds both in relation to the child realisations that can be explained in terms of consonant-consonant interaction (see II5. for consonant harmony), and with respect to the total number of utterances for each child. For instance, in the data of Tom (7), who has most instances of VC harmony, seven lexical items (20 forms) are observed that represent labial harmony, and four lexical items (six forms) representing coronal harmony out of the total of 1306 spontaneous utterances. Also, there are a considerable number of exceptions. In the output of the four children considered here, 39 lexical items of VC harmony are observed. From that same data, 21 exceptions emerge, namely, round vowels occurring with non-labial consonants and high vowels with non-coronal consonants. This set of data that contradicts the VC harmony proposal is discussed in 7.2.2.

### 7.2.2 Contrarities to the VC harmony predictions

The forms that do not satisfy the three-way VC relation claim are presented below: high vowels with consonants other than coronal (7.2.2.1), and round vowels with consonants other than labial (7.2.2.2.).

#### 7.2.2.1 Front vowels and non-coronal consonants

(10)	I						
a.	<i>die</i>	'that/those', dem.	/di/	[gi	'ki]	2	#1
	II	–				4	
	III						
a.	<i>die</i>	'that/those', dem.	/di/	[piə̃]		7	#7
b.	<i>fiets</i>	'bicycle'	/fits/	[kɪs]		7	#11
c.	<i>ezel</i>	'donkey'	/ezəl/	[kɪsɔv]		7	#15
d.	<i>web</i>	'web'	/vɛp/	[kɛk	'vɛk]	7	#18
e.	<i>een visje</i>	'fish', dim.	/visjə/	[χɪfjɛ]		7	#25
	IV						
a.	<i>kikker</i>	'frog'	/kɪkɔɪ/	[fɪp]		9	#9

In the above realisations (10I-IV), the high vowel interacts with a velar consonant (see 7.2.3.2).

#### 7.2.2.2 Round vowels and non-labial consonants

(11)

<b>I</b>								
a.	<i>koekje</i>	‘biscuit’, dim.	/kukjə/	[‘tuk’i:	‘tukjə]	2	#14-18	
b.	<i>ik ook <u>koekje</u></i>	<i>idem</i>	<i>idem</i>	[‘tukjə]		2	#18	
c.	<i>kabouter</i>	<i>idem</i>	<i>idem</i>	[‘tukjə]		2	#18	
	<i>ook een</i>							
	<i><u>koekje</u></i>							
<b>II</b>								
a.	<i>boeken</i>	‘books’	/bukən/	[‘butə]		4	#3	
b.	<i>broek</i>	‘pair of trousers’	/bruk/	[‘but’	‘but]	4	#3-9	
c.	<i>klok</i>	‘clock’	/klɔk/	[pɔʔt	‘pɔ:tə	‘tɔ:t	4	#3-9
				‘tɔt’	‘pɔt	‘tɔt]		
d.	<i>panda <u>ook</u></i>	‘also’	/ok/	[‘ɔt]		4	#4	
e.	<i><u>broek</u> mijne</i>	‘pair of trousers’	/bruk/	[‘bu:t]		4	#5	
f.	<i><u>kom</u> maar</i>	‘come then’	/kɔm/	[‘tɔma:]		4	#6	
	<i>staart</i>							
g.	<i>boek</i>	‘book’	/buk/	[‘but	‘burt]	4	#6-7	
h.	<i>ik ook</i>	‘me too’	/ɪk ‘ok/	[ʔi	‘tɔt]	4	#7	
i.	<i>Loetje <u>kom</u></i>	‘come then’	/kɔmens/	[‘tɔmɪʃ]		4	#8	
	<i><u>eens</u></i>							
j.	<i>koffiekoekje</i>	‘coffee biscuit’, dim.	/kɔfi‘kukjə/	[‘kɔftutjɛ]		4	#10	

## III

a.	<i>vos</i>	'fox'	/vɔs/	[vɔk]	7 #11
b.	<i>koe</i>	'cow'	/ku/	[tʉ]	7 #14
c.	<i>boek uit</i>	'book'	/buk/	[dukə]	7 #18
d.	<i>boek dicht</i>	<i>idem</i>	<i>idem</i>	[ɣun]	7 #18
e.	<i>een poes</i>	'cat'	/pus/	[kus]	7 #22

## IV

a.	<i>vogel</i>	'bird'	/voχəl/	[təχɔ]	9 #10
b.	<i>bloem</i>	'flower'	/blum/	[pɔŋ]	9 #11
c.	<i>eten</i>	'to eat'	/etən/	[ʔeʔjɔŋ]	9 #15

Similar to the pattern observed for the coronal harmony forms, the data sets in (11I-II), i.e. the output of Robin (2) and Eva (4), appear to present a regular phenomenon, whereas the forms produced by Tom (7) and Elke (9) are a group of exceptions (11III-IV). This last aspect is illustrated by the "status" of the utterances; for example, *vos* 'fox' 7 and *bloem* 'flower' 9 are first instances and occur only once. *Koe* 'cow' 7, *boek uit* 'book' 7, *eten* 'to eat' 9 and *vogel* 'bird' 9 are exceptions amidst regular realisations that have the same place of articulation as the target consonant, as illustrated in (12).

(12) a.	b.	c.	d.
<i>koe</i> /ku/ 7	<i>boek uit</i> /buk/ 7	<i>eten</i> /etə/ 9	<i>vogel</i> /voχəl/ 9
#8 [fβu]	#11 [bu'ka]	#3 [ʔet <sup>h</sup> a]	#8 [fofɔ 'fɔfo]
#10 [βu:]	#18 [buk 'dukə] <sup>4</sup>	#14 [ʔei ʔetsjə]	#9 [kuɔχɔ]
#11 [pʉ]	#19 [bukat]	#15 [ʔeʔjɔŋ]	#10 [fɔfɔχ tɔχɔ]
#14 [tʉ 'buχɛkə]	#20 [bukə]	#17 [ʔetə]	#14 [foχo]
#15 [vu:]	#21 [bu'kœyt]		#15 [foχɔ 'fɔχɔ]
#16 [ku]			#16 [fɔχo]
#22 [ku:]			#17 [foχou]
			#18 [fo'χu]
			#19 [foφja]

This leaves *boek dicht* 'book' 7 and *een poes* 'cat' 7, which is only realised once (11IIId.-e.). These forms are exceptions in the sense that *boek* and *poes* on their own are realised in agreement with the place of articulation of the target consonant. Namely, *poes* 7 is realised in #13-24 as [pVs] and, on one occasion (#14) as [pVJ], where [V] is a round vowel. Similarly, *boek* 7 has the form [pVk] or [bVk] in session #11-23, and [bVkaɪ] in #11. The other realisation of *boek dicht* 7

<sup>4</sup> The realisations of *boek uit* in sessions 11, 19 and 21 include are not followed by a separate realisation of target *uit* /œyt/ 'completed' following *boek*.

is in #20, and also has an initial labial consonant, [bɔi]. III and IV are thus concluded to represent exceptional realisations.

The realisations of Tom (2) and Eva (4) (11I-II) reflect the following regular pattern: a velar target consonant is realised as [t] in the presence of a round vowel. These realisations point to a general development, notwithstanding the contradiction this entails with regard to the vowel-consonant interaction claim (round vowels interact with labial consonants, and high vowels with coronal consonants) (Levelt 1994) (7.1.1.2). Considering the phonological system at the time of utterance, the place opposition is between labial and non-labial for all utterances in I and II. In this context, [t] can be regarded as the realisation of a non-labial segment. On the assumption that the child prefers or aims at a maximal contrast, and taking into account the free variation of alveolar and velar, it can be concluded that [t] is “more contrastive” in relation to a labial entity. [k] can thus be regarded as being more like labial than [t]. So, maintaining an optimal contrast before a round vowel gives rise to [t] for a target /k/, as observed in the child’s forms in (11I-II).

### 7.2.3 Representation

#### 7.2.3.1 Dependency phonology representation and the articulator model

The t/k-variation and the maximal unlikeness of alveolar and labial, as observed in the data, are discussed in 7.2.1.1 and 7.2.2.2. Relating these aspects to phonological representation, place of articulation is appropriately reflected by the following characterisation (Anderson and Ewen 1987:237):

(13)	labial	alveolar	velar
	[u]	[l]	[u,l]

Namely, in this dependency phonology specification of the main places of articulation, alveolar is characterised by a lingual component, which it has in common with velar. The interaction between these two places of articulation is thus assumed to be within the lingual space. Labial is represented by means of a labial component, [u], and does not have a representational common denominator with alveolar. Also, on the basis of this representation, it is not expected to observe a regular pattern representing an interaction between alveolar and labial. This aspect is investigated in 7.2.3.3 below.



Another issue relating to the dependency representation of place is the relationship between front vowels and alveolar consonants. Dependency phonology characterises alveolar consonants by means of a lingual component,  $[\text{ll}]$ . Front vowels receive the frontness or, in acoustic terms, acuteness/sharpness component,  $[\text{ii}]$ . The VC harmony proposal (Levelt 1994) predicts a close relationship between front vowels and coronal consonants. These segment classes are characterised with the same place feature, coronal, in accordance with the articulator model. More importantly, it is claimed that the coronal VC relationship is on a par with the predicted labial and velar VC interaction. This claim is not confirmed by the data observations (7.2.1-2), which are summarised below (7.2.3.2). First, however, the coronal claim itself is discussed.

Coronal describes those articulations that are ‘articulated with the front or blade (including the tip) of the tongue’ (Keating 1987:126; cf. Clements (1991) in 7.1.1.1), or with the tongue front, as opposed to the tongue body (Sagey 1988:170). It is applied to both vowels and consonants (see 7.1.1.1). Coronal is claimed, however, to obscure generalisations that are expressed by preceding characterisations. Kenstowicz (1994:464-65) discusses the replacement of  $[\pm\text{back}]$  by coronal and dorsal, and its consequences. These include, amongst other things, the loss of the insight that front and back vowels are opposites. Also, with regard to the description of processes involving consonants (Turkish vowel harmony and Arabic root co-occurrence constraints), coronal is required to be both a binary and a monovalent feature (for a discussion of these processes, see 1994:465). In this light, it is concluded that the adoption of  $[\text{coronal}]/[\text{dorsal}]$  in the place of  $[\pm\text{back}]$  is not successful.

Kenstowicz (1994) also puts forward ‘anatomical motivation for not identifying coronal consonants and front vowels’ (1994:465). There is a difference between the muscles that produce coronal articulations, and those that produce front vowels, namely, these are the intrinsic longitudinal muscles of the tongue (following the Sagey model, 3.1) and the external muscle connecting the tongue body and jaw (genioglossus), respectively. Thus, besides acquisition evidence (see 7.2.3.2), there is also acquisition-external motivation, both anatomical and representational, to not adopt the front vowel-coronal consonants relation described by the feature coronal.

The history of the description of place of articulation, and, more specifically, of coronal, is not the basic concern of the discussion here,<sup>5</sup> nor is the differentiation between natural classes in adult phonology as such. Rather, the adequacy or appropriateness of the different notational models is assessed in relation to the acquisition data from the ChildPhon database, which is discussed below (7.2.3.2).

#### 7.2.3.2 Summary and discussion of the data observations

The interaction between front vowels and coronal consonant in the ChildPhon data is adopted as evidence in favour of the articulator model (besides the labial and dorsal VC claim). An investigation of the data of the four children that is analysed here with regard to VC interaction reveals that the coronal VC interaction is not particularly strong. Besides model-internal problematic aspects concerning representation (see II2.) and despite the emphasis on the VC harmony phenomenon in Levelt (1994), the detailed discussion of the harmony forms makes clear the following:

- i) Vowel-consonant harmony is not a major phenomenon in the output of the four children studied (ChildPhon database). In terms of numbers, labial and coronal VC harmony are a modest side-effect (7.2.1.1-2). Moreover, there is a comparable set of exceptions to the vowel-consonant interactions that can not be accounted for by the articulator model (7.2.2.1-2).
- ii) The occurrence of non-labial consonants appears to directly reflect the state of the phonological system. The place opposition that is established first is labial v. non-labial. The realisation of [t] for /k/ before a front vowel (7.2.1.1),<sup>6</sup> as well as before a round vowel (7.2.2.2) is in agreement with the free variation that is created by the opposition labial v. non-labial (or its absence) that is valid for those realisations (in all but two cases: *poten pakken dan* (7) en *geen mes* (2)).

Note that there is a difference between the data from Robin (2) and Eva (4), whose data reflect a regular pattern, and Tom (7) and Elke (9), whose data present a set of exceptions (7.2.1.1, 7.2.2.2). Coronal harmony is not observed in the data of all children.

<sup>5</sup> For a comparative historical account see Keating (1987), and also Levelt (1994).

<sup>6</sup> The voiceless stops are used here as representatives for the group of consonants with the same place of articulation, of which voiceless stops are the most prominent group.

- iii) Those child forms that include the realisation of a velar consonant before a front vowel, in the place of an alveolar target, contradict the labial/coronal/velar model (7.2.2.1). Acknowledging the limitations of a small, albeit consistent, data set, this could be regarded as support for the assumption that the velar and alveolar place of articulation have a feature in common. More specifically, this could be taken as an indication for the presence of  $|l|$  in velar consonants.
- iv) The absence in the acquisition data of a regular pattern with forms in which a target labial consonant is realised as a coronal consonant in the presence of a front vowel is not predicted by the articulator model. This anomaly and the t/k-variation before front vowels as well as round vowels when the place contrast is labial v. non-labial (see ii.) points to the absence of coronal VC harmony as such. The t/k-interaction can be regarded as a reflection of the state of the phonological system. (See also 7.2.3.3., and II5..)
- v) The absence of a regular pattern of velar realisation of a labial target, expected because of the grave component they have in common, can be explained on basis of the properties of the dependency phonology components. Place components in simple combination, such as  $|u,l|$  in the characterisation for velar, are equal; they carry as much importance in the specification. Perceptually, however, each component is less strong than when it appears in isolation. The assumption is that  $|u|$  for labial is thus easier to perceive by the child than the  $|u|$  in the velar characterisation (see 4.4). So, the labial component for velar will not be identified with the labial place of articulation initially, as they are acoustically not similar enough.

### 7.2.3.3 Labial-alveolar interaction

The dependency phonology representation of place does not predict an interaction between labial and alveolar place of articulation, that is, that they are in free variation similar to the velar-alveolar variation, as the specification of these places of articulation do not have a component in common. Those forms that have a labial target and an alveolar realisation, or *vice versa* are considered here.

(14)	I	–				2	
	II						
	a. *	weg	‘gone’	/vɛχ/	[d̥ɪχ ‘dɛχ ‘jɛ’χ ‘d̥ɛχ ‘dæχ ‘dɪχ]	4	#1-3
	b. •	oma <u>toe</u>	‘to’	/tu/	[pu:]	4	#4
	c. •	panda <u>doen</u>	‘to do’	/dun/	[‘bu]	4	#4
	III						
	a.	dat	‘that’	/dat/	[‘va ‘vɑ ‘pa]	7	#5
	b.	die	‘that/those’, dem.	/di/	[piə]	7	#7
	c. •	uil	‘owl’	/œyl/	[‘ʔäuw ‘ʔaw ‘ʔauw ‘ʔauw ‘ʔauφ ‘ʔauw]	7	#12-16
	d. •	uit	‘out’	/œyt/	[‘häu ‘ʔœyφ ‘hœyφ ‘ʔauf]	7	#6
	e. •	neus	‘nose’	/nɔs/	[nɔf]	7	#17
	f.	<u>boek</u> uit	‘book’	/buk/	[dukə]	7	#18
	g.	is dat	‘is that’	/ɪs ‘dat/	[didap]	7	#19
	h. •	ezel	‘donkey’	/ezəl/	[ʔɪsɔw ‘kɪsɔv]	7	#13, 15
	i. •	<u>de spiegel</u>	‘mirror’	/spiχəl/	[piχow]	7	#25
	IV						
	a.	papa	‘daddy’	/papa/	[‘tapa]	9	#5
	b. *	kip	‘chicken’	/kɪp/	[ʔit]	9	#9
	c. *	weg	‘gone’	/vɛχ/	[lɛχ]	9	#14
	d.	vogel	‘bird’	/voχəl/	[tɔχɔ]	9	#10
	e. •	stoel	‘chair’	/stul/	[tuw]	9	#11
	f.	sjaal	‘scarf’	/sja:l/	[‘faw ‘saw]	9	#12
	g.	dat	‘that’	/dat/	[tāp]	9	#9
	h. •	uil	‘owl’	/œyl/	[‘ʔœyv ‘ʔauw]	9	#17, 18
	i. •	ballon	‘balloon’	/bɔˈlɔn/	[lɔm]	9	#19
	j. •	ballonnen	‘balloons’	/bɔˈlɔnən/	[lɔmə]	9	#19

Out of the 21 lexical forms (22 forms) in (14), 14 are instances of harmony, namely, 11 labial VC harmony (indicated by •), and three instances of front vowel-coronal consonant interaction (\*). In all but six cases, the target place of articulation has not been established yet. So, in these cases, harmony involves the “filling-in” of an empty, consonantal place slot through the vowel (cf. labial filling-in in II5.). As such, they do not present a variation of labial and alveolar. An empty consonantal slot can not be claimed for the remaining six cases; five alveolar targets with a labial realisation, and one labial target with an alveolar realisation. The five labial realisations of an alveolar target consonant are all cases of labial VC harmony, which can thus be regarded to be “persistent” given that a target place is assumed to be specified. Subsequently, it is concluded that

there is no regular pattern of alveolar-labial interaction. This, in turn, supports the dependency phonology specification of place. Concerning the cases of front vowel-coronal consonant interaction, mentioned above, this would point to coronal VC harmony. However, out of the three cases, two are first instances, and as a data set this does not offer sufficient evidence for coronal VC harmony (*kip* #9, *weg* #14 9).

Out of the six non-harmony cases in (14), five cases involve low vowels and non-dorsal consonant realisations (one labial target with an alveolar realisation, and four alveolar targets with a labial realisation), and as such do not conform to the labial/coronal/dorsal model. For a discussion of low vowels, see 7.2.4.

#### 7.2.4 Low vowels

The investigation into the claim of the three consonant-vowel relationships in 7.2.1-2 has concentrated on the labial and coronal claim. Dorsal VC interaction is discussed here. The vowels that correspond to dorsal consonants are both back and low vowels, following Levelt (1994) (see 7.2.1). Back vowels in Dutch are also round, except for /a/ (see (4), overview of Dutch vowels). On the basis of the late(r) emergence of dorsal consonants in the output of the children studied (ChildPhon), it is assumed that, in the initial stages of acquisition, the round, back vowels are specified for labial, rather than for dorsal. This rationale, however, does not apply to the low vowels /a a/, and their only consonantal connection is with dorsal. Below, all realisations with a low vowel and a consonant realisation that is different from the target consonant with regard to place are listed.

(15) I					
a.	<i>ik groot</i> <i>kaakje</i>	'biscuit', dim.	/kakjə/	[tʰaki]	2 #15
b.	<i>gekke mamma</i>	'crazy, strange'	/χekə/	[sʷakə]	2 #19
c.	<i>is dat nou gek</i> <i>boekje</i>	'strange'	/χek/	[sʷək]	2 #19
d.	<i>pappa komt</i> <i>morgen thuis</i>	'comes'	/kɔmt/	[tʰam]	2 #19
II					
a.	<i>maken</i>	'to make'	/makə/	[na:tə]	4 #2
b.	<i>kwak</i>	'quack'	/kuak/	[tʰat]	4 #2
c.	<i>tuin</i> <i>openmaken</i>	'to open'	/opəmakə/	[ʔo'pəma:tə]	4 #5
d.	<i>kachel</i>	'heater'	/kaχəl/	[tʰa'χ'o:m̩ tʰa:təχ]	4 #5-6

e.	<i>daar</i> <i>openmaken</i>	'to open'	/opəmakə/	[ʔopəma:tə]	4	#6
f.	<i>ik openmaken</i>	<i>idem</i>	<i>idem</i>	[ʔo:pəma:tə:]	4	#7
g.	<i>toren maken</i>	'to make'	/makə/	[ma:tə]	4	#8
h.	<i>jij hebt koude</i> <i>voeten</i>	'cold', adj.	/kaut/	[tau]	4	#10
<b>III</b>						
a.	<i>dat</i>	'that'	/dat/	[pa 'va 'vɑ]	7	#5
b.	<i>klok</i>	'clock'	/klɔk/	[kap]	7	#12
c.	<i>gevallen</i>	'fallen'	/χə'valən/	[fɑŋ]	7	#16
d.	<i>is dat</i>	'is that'	/is 'dat/	[dɪ 'tak 'didap]	7	#19
e.	<i>doet ie nou</i>	'now'	/nau/	[haup]	7	#21
f.	<i>poten pakken</i> <i>dan</i>	'then'	/dan/	[kɑ:n]	7	#21
g.	<i>kabouter</i>	'gnome'	/ka'bautər/	[ta'bauci]	7	#23
<b>IV</b>						
a.	<i>daar</i>	'there'	/daɪ/	[ka:]	9	#2
b.	<i>banaan</i>	'banana'	/bə'nan/	[maŋ]	9	#4
c.	<i>papa</i>	'daddy'	/papa/	[tapa]	9	#5
d.	<i>dat</i>	'that'	/dat/	[təp]	9	#9
e.	<i>sjaal</i>	'scarf'	/sja:l/	[saw 'faw]	9	#12
f.	<i>kijk wang</i>	'cheek'	/vaŋ/	[van]	9	#17

From the realisations in (15), it becomes clear that only a small subset satisfies the prediction that the presence of a low vowel gives rise to a velar consonant. As such the inclusion of low vowels under dorsal is not confirmed by the data from the four children. Parallel to the findings for "coronal harmony" cases and t/k-variation before round vowels, the data sets of Tom (7) and Elke (9) consist of exceptional forms and first instances, whereas Robin's (2) and Eva's forms (4) are part of a more regular pattern. Here too, the latter, more regular data sets (15I-II) are realised when the place contrast is between labial v. non-labial, or is still absent; out of the 12 forms, ten involve a velar target and an alveolar realisation, and the remaining two have an alveolar target and a velar realisation. So, also before low vowels, there is a t/k-variation that confirms the findings in 7.2.3.2. This thus underlines that the occurrence of coronal and velar consonants before the stabilisation of the three-way contrast for place reflects the state of the phonological system, rather than that this is determined by VC interaction according to the articulator model.

### 7.3. Conclusion

In order to test the adequacy of the labial/coronal/dorsal model of place representation (feature geometry) as well as the dependency phonology specification of the three main places of articulation, the consonant realisations in the data of four children have been studied in detail. Starting point is the VC harmony proposal in Levelt (1994), claiming support for the articulator model in early acquisition. This proposal assumes that the three vowel-consonant relations are to a considerable extent responsible for the child's realisations of place for consonants.

The predicted relations between round vowels and labial consonants, front vowels and coronal consonants, and back vowels and dorsal consonants are not confirmed by the acquisition data studied here (ChildPhon database, childno. 2, 4, 7 and 9; see 7.2.1 and II1.2.1). The data observations make it clear that the labial and coronal VC harmony cases (7.2.1) are a modest phenomenon that has a relatively large number of exceptions (7.2.2). The occurrence of [t] for target /k/ represents a regular pattern in the output of some children before front vowels and round vowels (and, to a lesser extent, before low vowels) (7.2.1.1, 7.2.2.2 and 7.2.4, respectively). This is not in agreement with the VC harmony proposal. The t/k-variation appears to reflect a close relationship between alveolar and velar place of articulation. The absence of coronal harmony with target labial consonants, and the absence of a regular pattern of dorsal harmony ("back vowels" include back, round vowels that are involved in labial harmony as well as and low vowels that do not show dorsal VC harmony (7.2.4)) contribute to the rejection of the articulator model as descriptive device for the acquisition process. See also 7.2.3.2. There is also representational (based on adult language) and anatomical evidence to reject a uniform specification for coronal consonants and front vowels (7.2.3.1).

The dependency phonology characterisation of place ([u] labial, [l] alveolar, [u,l] velar) can explain the t/k-variation as free variation within the lingual space, whilst the place contrast is labial *v.* non-labial. The [t] realisation before round vowels creates a maximal contrast as (the representation of) labial and alveolar do not have a place component in common (7.2.2.2). [t] and to a lesser extent [k] occur before front vowels (7.2.1.1, 7.2.2.1), thus confirming the shared lingual quality in dependency terms for alveolar and velar place of articulation. The relationship between lingual consonants and front vowels is not indicated by the same place component for consonants and vowels (7.2.3.1). High vowels are characterised by the [i] component, indicating



acuteness or, articulatorily speaking, frontness/palatility. Alveolar consonants are part of the natural class of lingual consonants, indicated by the  $||$  component. With regard to labial VC harmony, this affects target /t/ as well as target /k/, and is not restricted to a certain stage in the place development of the child (7.2.1.2). The predicted absence of p/t-variation, on the basis of the labial and alveolar specification in dependency phonology that do not have a place component in common, is confirmed by the data (7.2.3.3). This points to labial VC-interaction as the only observed phenomenon of the three proposed VC harmony processes. This is expressed appropriately by the dependency place representation; both labial consonants and round vowels receive a  $|u|$  component. This is also supported by the discussion of the Sagey-model (labial/coronal/dorsal) in Kenstowicz (1994). This model only acknowledges evidence for the idea that '[round] is the vocalic expression of labiality in consonants' (1994:462).

Insufficient evidence has been found in support of a complete three-part VC harmony proposal. On this ground, the articulator model is rejected as offering a transparent description of the acquisition process. On basis of the data observations discussed, the dependency phonology characterisation is concluded to adequately reflect the place of articulation aspect of early phonological acquisition. Only labial vowel-consonant interaction is adopted.

## 8. Conclusion

Section III has presented a discussion on segmental representation within the context of early phonological development. Various notational models have been assessed on their suitability to represent the early stages of phonological acquisition. They are binary features, feature geometry, dependency phonology, radical CV phonology and articulatory phonology (2.-6.). The development of segmental specification constituted by (some of) these models (features, non-linear phonology, hierarchical groupings, etc.) is briefly discussed in 1..

Binary (Jakobsonian) features are able to express phonological development in the early stages of acquisition as far as the manner classes is concerned. The underlying dimension of this process, i.e. sonority, however, is not expressed in a binary acquisition account, and the representation is thus not insightful in this respect. The standard specification of labial is [+grave, -compact]. From an acquisition point of view, neither feature can describe the labial place of articulation on its own as both features include another natural class (velar and alveolar consonants, respectively). The binary features proposed in SPE provide a similar characterisation, apart from the representation of the nasal stops and the liquids. Nasals are specified for [sonorant] rather than for [nasal]. This reference to sonority is not explicatory in an acquisition context as it does not acknowledge the relevance of this developmental aspect, namely that the relative degree of sonority interrelates the different groups of segments in acquisition. With regard to the liquids, these can not be characterised as a natural class (2.1). The markedness of segments in SPE does not seem to offer a solid basis for the child in the acquisition of his first contrasts. Generally, unmarked segments are acquired before marked ones. However, the SPE description does not offer gradual and increasing markedness in the course of early acquisition (besides the innateness query regarding the markedness conventions) (2.2).

Feature geometry has to satisfy the monotonicity principle according to the founding principle that functional feature groupings constitute nodes (and the assumption that acquisition proceeds gradually) (3.1). Also, acquisition of new nodes is assumed to affect the lower end of the geometry branches so as to maintain the universality of the tree. The different geometry proposals evaluated are Sagey (1986, 1988), Clements (1985) and Rice (1992). Geometry models that have the main

manner features placed directly under the root node are less likely to violate the monotonicity principle. In this respect, Clements (1985) is less successful in representing early phonological development (3.2), and Sagey (1988) proves least problematic (3.1). The nodes specified for the different acquisition stages are sometimes rather obscure. For instance, Supralaryngeal is specified to characterise nasal stops (Sagey 1986), and Place is specified to indicate labiality (Sagey 1988) (3.1). These specifications are not genuinely meaningful given the acquisition context. Moreover, it raises doubts regarding the identity of the geometry features in the description of child and adult language. Little insight is provided by the acquisition scenarios of the different geometries regarding the sonority dimension. The feature [sonorant] is available for the characterisation of the nasal stops. However, this only concerns one contrastive entity, and does not reflect the relevance of the relative degree of sonority that characterises the contrastive entities (see above). The Rice (1992) proposal that regards the expression of sonority in terms of amount of structure seems to be bound to fail from an acquisition point of view. If least and most sonorous, and thus least and most structure, are among the early contrasts, then a violation of the monotonicity principle is inevitable (given that geometry representation is universal rather than relative, and that there are at least five manner categories to be expressed) (3.3).

Articulatory phonology presents an attractive idea, *a priori*; the child's early phonological system can be expressed by means of gestures that reflect the movement of the articulators. However, the evaluation in 6. of the model as it is presented and applied to child language (Browman and Goldstein 1989, Studdert-Kennedy and Goodell 1995) presents serious flaws with regard to the representation of the acquisition process as well as to more general aspects of the model. The adoption of the gesture as basic unit implies the assumption that there is one lexical component for phonetic and phonological representation, based on the timing of articulatory movement. No auditory information is available to the child through his representation, and auditory feedback does not appear to be a possibility for the child, albeit a necessity (Vihman 1991) (6.2.1-2).

To reflect the realisation of consonants by the child appropriately, some form of non-contrastive non-specification is required (II4.-5.). This is not possible in the gestural score notation. The discrepancy between target and realisation (t/k-variation, labial filling-in, etc.) can thus not be expressed. Variability is explained with reference to gesture control. However, this is descriptive at a phonetic level rather than insightful at a phonological level; the difference between variable

and stable forms, and between context-dependent and free variation does not become clear. With regard to the acquisition scenario, the most basic contrast vowel *v.* consonant can not be expressed (6.3.1), nor is sonority even mentioned representationally. Overall, the representation of the early stages is opaque, particularly because it refers to the descriptors and not to the relevant gestures.

Tube geometry, the fusion of the gesture and the feature geometry hierarchy, incorporates a representation of constriction degree based on percolation throughout the hierarchy, from bottom to top (6.3.2). (Note that this mechanism is in contrast with the assumption that manner features are better posited directly under the root node (see above).) As the tube hierarchy is the child's phonological and phonetic structure at the same time, there is a clash; more information is required phonetically to provide the child with information about his variable realisations (which are the basis for his phonological development), less information is required phonologically as only the basic contrasts are represented. Also, the same hierarchical problems related to feature geometry and the monotonicity principle are encountered by the tube geometry representation.

The expression of the scalar phenomenon of sonority is one of the initial motivations behind dependency phonology. Indeed, dependency phonology and the related radical CV phonology are successful in reflecting the initial sequence of natural classes that function as contrastive entities in the child's system, in terms of relative sonority (apart from the representation of nasal stops in radical CV phonology) (4.4 and 5.2, respectively). In radical CV phonology, though, the representation of the initial place of articulation, labial, proves problematic. Labial is represented as marked on the basis of its complex specification which is not reconcilable with the observation that it is the first place of articulation to be acquired by the child. Also in this respect, the claim that labial is perceptually less clear than alveolar appears anomalous. The non-specification of velar makes the wrong predictions; velar is not the first place of articulation to be realised by the child, and velar segments are not filled-in by specified places (5.2).

Dependency phonology is able to express phonological development represented by the early contrasts in the child's system. The representation of the contrastive entities concerning manner of articulation is in terms of  $|V|$  and  $|C|$  components, where the representation of entities evolves in the representation of developmentally later contrasts. The (preponderance of)  $|V|$  components

expresses the relative degree of sonority, which underlies the early oppositions. The dependency notation thus offers a flexible and appropriate representation that reflects a gradual increase in complexity. This notational model also offers the insight that the first consonantal contrast the child acquires, oral stop *v.* nasal stop, is based on the opposition plosive *v.* non-plosive. The representation of plosive in other models is not (as) straightforward. Dependency phonology is also capable of accounting for place of articulation (see below).

Overall, the assessment of the various notational models concerning the representation of segmental structure seems to point to dependency phonology as being most successful in this respect. This model offers a coherent and insightful account of the acquisition of the contrastive entities or natural classes that are relevant in the contrasts of the early acquisition of phonology. In this context, it can be claimed that the type of relations expressed in feature geometry (basically what is expressed by the inter-node lines in the representation) is less successful than the relations between dependency phonology components (see below).

In feature geometry, dominating and subordinate features are dependent in the sense that the presence of the former entails the presence of the latter (McCarthy 1988:98). This is referred to as *structural dependency* in Ewen (1995).

There is no claim that the *content* of the features involved is in any way affected by the dependency relation: the dependent feature is in no sense less prominent than the "dominating" feature (1995:81).

This is different from the relations holding between dependency components within the segment. This is 'a relation holding between two elements - features - which characterises the relative contribution of each of the elements to the segment', i.e. *inherent dependency* (1995:580) (see 4.2). Dependency representation is also relative in the sense that segments are characterised taking the other members of the system into consideration. The intra-segmental relations in dependency phonology can thus be said to be concerned with the representation of the components in a segment relative to the other entities in the system. Feature geometry, in this respect, aims to capture constraints of the articulators in a universally valid way. From the discussion of the different notational models, it becomes clear that system-internal considerations serve the representation of early phonological development better than universal ones.

With regard to the representation of place in the early stages of phonological development, the place of articulation labial features prominently as it is the first stabilised place, and thus place specification, in the child's system (II3.-5.). The notational frameworks assessed offer an opaque representation for labial from an acquisition point of view, apart from dependency phonology. The inability of the models can be explained with reference to the hierarchical relations that are expressed between different features, i.e. structural dependency (see above) (feature geometry and tube geometry), with reference to the explicit assumptions of the model (articulatory phonology), or with reference to the choice of features to describe segments, be they binary or monovalent (binary feature theory and radical CV phonology). Because of the simplicity of the labial representation in the dependency framework, namely the labial component  $[u]$ , this notation is able to offer an appropriate characterisation of the first place of articulation that the child acquires.

A detailed evaluation of the place characterisation of the three main places of articulation in dependency phonology and the articulator-based model (without the structural dependency) is concluded in favour of dependency phonology. The predictions expressed by the labial/coronal/dorsal specification and its subsequent vowel-consonant relations, i.e. the core of the VC harmony account in Levelt (1994), are not confirmed by the data (ChildPhon data from four children). The only consonant-vowel connection that is consistently observed in the data is between labial consonants and round vowels. The labial-lingual notation proposed by dependency phonology reflects the place of articulation development adequately.

The evaluation of the suitability of the notational models of phonology to describe the acquisition of phonology in III can thus be concluded. Dependency offers an adequate and insightful model to describe early phonological development.



## Summary and conclusion

In this thesis, the development of early phonological acquisition has been examined in relation to the phonological representation of the child's segments, and on the basis of the phenomena observed in the data analysed.

Part I is concerned with the formulation of a base of assumptions regarding early phonological development to support the data analysis. Innateness and early cognitive development are discussed on the basis of existing literature. Subsequently, the innateness assumption adopted here is formulated as a cognitive-based constructivist approach to acquisition with innate attention-biases. The child is regarded as having the innate ability to form his own concepts or representation of the world, i.e. to internalise external information (I1.-2.). Regarding phonological acquisition, he is assumed to have a phonetic representation and a phonological representation, reflecting his own abilities. In this context, phonological processes or rules are rejected as an insightful acquisition mechanism; they are based on the assumption that the child's phonological representation is adult-based, and richer than becomes evident from his output. The perception/production model adopted here represents child-based structure only. Once the child has established a phonetic feature representation, his phonological representation is distilled from this through representational redescription. This is a reiterative, cognitive, domain-general process of analysis that redescribes the child's phonetic, and also phonological, structure, generating a higher level of representation, which in turn is also redescribed, etc. (I4.). Ultimately, this results in the child's phonological system, which is the most abstract representation of the child's phonological abilities at any one time. This process can also be regarded as the gradual abstraction of the relation system of sense from the reference and denotation systems in the phonological domain (I3.).

Part II discusses the data and the method used to reconstruct the development of the child's phonological system. The longitudinal data of five Dutch children and two English children between 1;0.10 and 1;6.4 at the onset of recording is taken into account for the study here. The Dutch child utterances are taken from the ChildPhon database that offers naturalistic data recorded fortnightly for the period of a year. The English child forms, similar in nature, are



recorded with shorter time intervals, and this data was apportioned into two week periods for the purpose of the data analysis here. On the basis of clinically based proposals concerning phonological analysis, a method of data processing and analysis is decided on in order to establish the phonological contrasts for each child for each session. This is the basis for the reconstruction of the evolution of the phonological system. The single consonantal phones of spontaneous utterances are logged as well as the target phones for which the child realisation is different from the target phone. This information in combination with the diachronic development of the child realisations of target words makes it possible to identify the system underlying the child's utterances for each recording session. The development of the phonological system of each of the children here is characterised by the acquisition of the same (order of) phonological oppositions. These trends are the basis for the discussion on phonological representation in III (I3.). With regard to the statistical analysis of the data used, it is concluded that neither descriptive nor referential statistics are insightful and/or meaningful for the phonological analysis (III.)

The child's realisation of place of articulation in the data used for this study is typically variable in comparison to the target word. This characterisation of the early stages of phonological development has been related to assimilation processes, such as consonant harmony. Recent proposals have presented models of place development based on underspecification that are claimed to offer an account of the child's variability in the realisation of place. An examination of some of these proposals reveals that none of them offers an appropriate account of the development of place as it is observed in the data of the children studied here. Some of the problematic aspects are: the lack of information regarding the state of the phonological system of the subjects whose data is used to illustrate, for example, assimilation processes, in these proposals; different interpretations of a feature geometry node for child and adult language, thus violating the continuity hypothesis; the absence of a clear indication why and how the assimilation cases disappear from the child's output whilst underspecification is assumed to be part of the adult's phonology; the predictions (expressed by the learning paths of a deterministic model of acquisition) with regard to the order of acquisition are not in accordance with the data findings; the evidence presented in favour of coronal underspecification (in the form of assimilation processes and order of acquisition) has been concluded to be inappropriate as it is concerned with purely phonetic observations. To account for the child's variable realisation of place through VC

harmony in combination with (coronal) underspecification is problematic as coronal is required to be specified as a trigger, amongst other things (II2.).

Underspecification, in the context of the proposals discussed here, is a simple extension of phonological structure from the centre to the periphery, i.e. imposing adult structure on the child's acquisition process. It appears that coronal underspecification is assumed to be present at the onset of speech on the basis of its universal character (which is different from the language-particular basis as proposed in Archangeli (1984)). Overall, a discussion of questions relating to the innate status and acquisition mechanism of underspecification is absent. On the assumption that the assimilation observations in the data analysed can be explained with reference to the actual development of contrasts within the child's system (see below), coronal underspecification has been rejected as an acquisitional characteristic during the early stages of acquisition. However, Gierut (1996) proposes (coronal) underspecification for children between 3-5 years, and the consensus in the literature adopts coronal underspecification in adult language. This raises the spectre of (the nature of) a possible scenario reflecting the acquisition of underspecification, for instance, what is the mechanism and what is the motivation for the child to implement underspecification in his phonological system. These aspects require more research (II4.).

Examination of the development of place of articulation in the data of the seven children studied here, in relation to the variability of place realisation in the child forms, makes it clear that an increase of the number of place contrasts in the child's system coincides with a decrease in the variability of place in comparison to the target words. More specifically, it has been concluded that the actual (variable) realisations can be accounted for on the basis of the developmental stages observed. These stages are the following: *no place specification* - variable realisations, non-contrastive non-specification before the establishment of labial; *labial specification* - variable alveolar and velar realisations and labial filling-in of non-labials, non-contrastive non-specification of non-labial segments after the establishment of labial; and *no articulatory variability* - contrastive specification of the three main places of articulation. Consonant harmony has thus been concluded to be motivated by lack of specification, and to be a system-internal, regular developmental phenomenon. The early establishment of labial explains the labial dominance in the child's output during the early stages of phonological acquisition. Coronal underspecification has been rejected and non-contrastive non-specification has been assumed to

account for the assimilation observed, i.e. the deviant behaviour of coronal during early acquisition (II5.).

The child's first phonetically consistent form, or protoword, has meaning only in combination with an object and an action, which constitutes a triad script. This script is decontextualised, and the phonetic member of the script has meaning on its own. The structure of this "word" is fixed, however, in that particular sounds are restricted to particular structures. As the child's abilities develop, the production of this wordpattern becomes less holistic: individual sounds are mastered and the originally fixed structure becomes more varied. In the output of the children studied here, the CV structure is a salient feature, which functions and develops in a manner comparable to event representations (I3.). Namely, the child is assumed to perceive his acoustic input through existing wordpatterns, or phonological structure, as these are familiar to him. His output is based on existing structure, and new words are acquired on the basis of an old pattern (reinforcement; I5.) (see below). The character of the dominant CV unit, phonologically speaking, is maximally contrastive; the typical realisation (stop+vowel) entails the least and most sonorous segment. In terms of optimality theory, it is the optimal syllable as it does not violate any constraints. From a cognitive perspective, CV protostructure constitutes a stable framework that offers practice space, in the form of the different slots, in which the child can classify perceptual information in a functionally relevant way by means of the grouping principles substitutability, contiguity and similarity. Categorical and articulatory information is thus gradually discovered by the child and phonologically acquired. In the child's output, the dominant role of the CV protostructure becomes evident from the  $C_xVC_xV$  realisations (traditionally regarded as being the output of consonant harmony and reduplication; I6.-7.). The child is assumed to perceive a target with familiar and unclear elements; he can represent the familiar part in the protostructure, and the remaining blank part of this structure is filled in by means of the familiar element(s) (II9.).

Vowel-initial targets and consonant clusters are a significant deviation from the child's protostructure, and the child's output gives evidence of various (target) situations in which the protostructure makes realisation possible. These "strategies", observed in the data analysed, are all concerned with the realisation of a (complex) target by means of the protostructure. For instance, the breaking-up, reduction or fusion of consonant clusters, resulting in a  $C(VC)$  realisation; and the interaction across words to achieve  $CVCV...$  (II7., II10.). The slot of a

complex consonant (cluster) is also assumed to be unspecified in the child's representation, and subsequently filled-in through spreading from a segment in the word (cf. labial filling-in) or to be realised as a dummy consonant, i.e. [h ?]. Dummy consonants can be regarded as being default markers of consonantality, from a phonetic point of view, and confirm the articulatorily unspecified character of these segments (II6.). The output of individual children gives evidence of a protostructure that incorporates articulatory and/or categorial information, i.e. a wordpattern, for instance, the [tV] sequence for Jarmo that is used in the realisation of complex targets (II8.). The importance of the protostructure for the child's phonological development is illustrated in the data of the seven children studied here by the different strategies that ensure realisations compliant with CV structure, which in turn illustrates the child's versatility in coping with targets that he has not mastered yet.

Part III focuses on the relationship between the development of the child's phonological oppositions and the notation of this process in terms of phonological representation. The developmental trends present in the evolution of the phonological system of the children studied are the basis for the discussion here. The early oppositions in the child's system concerning manner of articulation are oral stop ↔ nasal stop, stop ↔ continuant, fricative ↔ liquid (in that order). This development is most insightfully regarded in terms of (relative degree of) sonority. The child's early contrasts express the maximal contrast in the phonological space available. In order to adequately express this acquisitional characteristic, i.e. the scenario of early contrasts, the suitability of various models of phonological specification is evaluated, namely articulatory phonology, binary features, radical CV phonology, feature geometry and dependency phonology. (The development of place of articulation was simultaneously taken into account for this evaluation; see below.) Following the continuity hypothesis, notational models are expected to have the ability to represent both adult and child language by similar representational means (Introduction).

Articulatory phonology has been presented in the literature with specific reference to early child language. However, the model lacks attributes that are regarded here as being a requirement for the description of the acquisition process. For instance, no distinction is made between the child's phonetic and phonological representation, and variability can not be expressed with reference to (non-contrastive) non-specification, rendering the child's phonological representation merely

descriptive (III6.). Binary features are not successful in expressing the first place of articulation, i.e. labial, in the child's system, nor do they offer a coherent account of sonority as a scalar feature (III2.). Radical CV phonology makes the wrong predictions concerning the order of acquisition (III5.).

Models based on feature geometries are by definition bound by the monotonicity principle, which in some cases gives rise to an opaque relation between the node specified and the contrastive entity described. Specification of the main manner features directly under the root node is concluded to offer a more successful account of early phonological acquisition. Generally, the feature geometrical models studied do not offer an insightful representation of sonority as the acoustic characteristic underlying the early (manner) contrasts (III3.). The founding notion of feature geometry, structural dependency, can be concluded to be inappropriate in the context of child language. Structural dependency is related to the trend observed in Keating (1987), who in her survey of phonological features discusses the development that some features have been replaced by structure: 'The development of feature geometry extends this trend further: representing natural classes is now done by hierarchical structure as well as by features themselves' (1987:142). From the point of view of acquisition and its representation, this trend is not desirable.

Dependency phonology offers an insightful representation of the relative degree of sonority in terms of (preponderance of)  $|V|$  components. The child's entities can thus be represented with direct reference to the notion that underlies his contrasts. Also, this representation is flexible and reflects a gradual increase in complexity, expressed by means of dependency relations indicating inherent dependency (III4.). System-internal rather than universal considerations are thus concluded to be pivotal to the acquisition process (cf. the discussion of the relation system of sense in the phonological domain, I3.1). Furthermore, with regard to early place development (see above), a close investigation of the ChildPhon data has shown that the dependency phonology characterisation in the articulatory gesture, in terms of a labial and a lingual component, adequately reflects the child's phonological development. The labial consonant-vowel relations, predicted by (most) feature geometry labellings, have been confirmed by the data. However, the dorsal and coronal relation has been rejected, and consequently the VC harmony account of the child's place (III7.) realisations.

The study carried out in this thesis has shown that a child-based cognitive account of early phonological development is able to provide an insight into the nature of this acquisition process.



The gradual formation of phonological knowledge, in the form of an increase of phonological contrasts and structure in the child's phonological system, reflects his, still limited, abilities and can explain phenomena such as consonant harmony and other protostructure strategies. The child's protostructure, and the combination of blank slots and specifications give rise to filling-in phenomena, or assimilation. Also, the CV protostructure is cognitively salient to the child and makes possible the realisation of complex structures. Overall, the assumption regarding the autonomy of the child's system (and subsequent rejection of external devices or structure) and the development of phonological structure, primed for system-internal considerations, presents the child's phonological acquisition as the development of a minimally specified system. This development reflects the child's cognition and is instantiated by his redescribed representations in the phonological domain. The child's system gradually increases with regard to the number of elements and (the complexity) of inherent dependency relations. The notion of (relative degree of) sonority underlies the child's early contrasts (cf. attention-biases or innate constraints). The notational model of dependency phonology is able to present an appropriate and insightful specification of the acquisition scenario. The initial consonantal contrast in the categorial gesture is between plosive *v.* non-plosive, and subsequent contrasts are maximally contrastive in terms of sonority in the phonological space available, representationally reflected in the preponderance of  $|V|$  components. The early dominance of labial can be captured by the precedence of the specification of the  $|u|$  component in the child's system (in combination with the filling-in of (phonologically) non-labial segments). The specification of the labial and lingual components does not indicate order of acquisition, in accordance with the continuity hypothesis, that is, with regard to their interrelation in later stages of development. The notation offered by dependency phonology allows for an expression of the cover symbols, which have been shown to be required in the context of wordpatterns (15.).

The account of early phonological acquisition here is assumed to be psychologically real to the child, in terms of Grunwell (1985). Further investigation of the application of the model of development proposed to the development of phonologically impaired children (cf. Chin and Dinnsen 1992; Gierut, Simmerman and Neumann 1994) and speech therapy methods are required to test the validity of this assumption.

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Appendix A - Correlation between observation session and recording date(s).

<b>2 Robin</b>		<b>4 Eva</b>		<b>7 Tom</b>		<b>8 Jarmo</b>		<b>9 Elke</b>	
#1	8/11/89	#1	19/10/89	#1	30/10/89	#1	22/9/89	#1	1/11/89
#2	22/11/89	#2	2/11/89	#2	13/11/89	#2	6/10/89	#2	15/11/89
#3	7/12/89	#3	8/12/89	#3	27/11/89	#3	31/10/89	#3	29/11/89
#4	20/12/89	#4	22/1/90	#4	20/12/89	#4	17/11/89	#4	20/12/89
#5	10/1/90	#5	29/1/90	#5	2/1/90	#5	1/12/89	#5	6/1/90
#6	24/1/90	#6	19/2/90	#6	16/1/90	#6	19/12/89	#6	17/1/90
#7	7/2/90	#7	15/3/90	#7	30/1/90	#7	2/1/90	#7	31/1/90
#8	21/2/90	#8	29/3/90	#8	20/2/90	#8	16/1/90	#8	14/2/90
#9	1/3/90	#9	10/4/90	#9	6/3/90	#9	30/1/90	#9	28/2/90
#10	7/3/90	#10	15/5/90	#10	20/3/90	#10	13/2/90	#10	14/3/90
#11	21/3/90			#11	3/4/90	#11	27/2/90	#11	4/4/90
#12	4/4/90			#12	17/4/90	#12	13/3/90	#12	18/4/90
#13	18/4/90			#13	1/5/90	#13	27/3/90	#13	2/5/90
#14	4/5/90			#14	15/5/90	#14	10/4/90	#14	23/5/90
#15	18/5/90			#15	29/5/90	#15	24/4/90	#15	13/6/90
#16	1/6/90			#16	12/6/90	#16	8/5/90	#16	28/6/90
#17	15/6/90			#17	26/6/90	#17	1/6/90	#17	3/8/90
#18	4/7/90			#18	10/7/90	#18	12/6/90	#18	22/8/90
#19	23/7/90			#19	14/8/90	#19	26/6/90	#19	5/9/90
#20	24/8/90			#20	4/9/90	#20	10/7/90		
#21	7/9/90			#21	18/9/90	#21	31/7/90		
#22	19/9/90			#22	2/10/90	#22	13/8/90		
#23	5/10/90			#23	23/10/90	#23	5/9/90		
#24	26/10/90			#24	20/11/90				
				#25	8/1/91				

**J Jane**

#1	12/10/68	3/5/69	#10
	15/10/68	4/5/69	
	19/10/68	5/5/69	
	23/10/68	11/5/69	
	24/10/68	12/5/69	
#2	31/10/68	13/5/69	
	2/11/68	24/5/69	#11
	7/11/68	26/5/69	
#3	18/11/68	1/6/69	#12
#4	29/11/68	5/6/69	
	6/12/68	16/6/69	#13
#5	10/12/68	21/6/69	
	20/12/68	2/7/69	#14
#6	27/12/68	7/8/69	#15
	3/1/69	20/8/69	#16
#7	19/3/69	30/8/69	#17
	28/3/69	13/9/69	#18
#8	7/4/69	21/9/69	#19
	10/4/69	4/10/69	#20
	13/4/69	7/10/69	
#9	22/4/69	10/10/69	
	27/4/69		
	29/4/69		

**L Lucy**

#1	12/10/68	#10	3/5/69
	16/10/68		4/5/69
	19/10/68		5/5/69
	22/10/68		11/5/69
	23/10/68		12/5/69
	24/10/68		13/5/69
#2	31/10/68	#11	24/5/69
	2/11/68		26/5/69
	7/11/68	#12	1/6/69
#3	18/11/68		5/6/69
#4	29/11/68	#13	16/6/69
	6/12/68		21/6/69
#5	10/12/68	#14	2/7/69
	20/12/68	#15	7/8/69
#6	27/12/68	#16	20/8/69
	3/1/69	#17	30/8/69
#7	19/3/69	#18	13/9/69
	28/3/69	#19	21/9/69
#8	7/4/69	#20	4/10/69
	10/4/69		7/10/69
	13/4/69		10/10/69
#9	22/4/69		
	27/4/69		
	29/4/69		

Appendix B - Output sheet.

outputsheet

child no. : session no. :  
session date :

phonemes

initial

m		n		ŋ			
p		t		k		ʔ	
b		d		g			
v		s		x			
f		z					
ɸ		θ				h	
β		ð				ɦ	
		ʃ		ʒ			
		ʒ					
w		l		j			
ʋ		r		ɾ			

medial

m		n		ŋ			
p		t		k		ʔ	
b		d		g			
v		s		x			
f		z					
ɸ		θ				h	
β		ð				ɦ	
		ʃ		ʒ			
		ʒ					
w		l		j			
ʋ		r		ɾ			

final

m		n		ŋ			
p		t		k		ʔ	
b		d		g			
v		s		x			
f		z					
ɸ		θ				h	
β		ð				ɦ	
		ʃ		ʒ			
		ʒ					
w		l		j			
ʋ		r		ɾ			

m	n	ŋ	
p	t	k	ʔ
b	d	g	
v	s	x	
f	z		
ɸ	θ		h
β	ð		ɦ
	ʃ	ʒ	
	ʒ		
w	l	j	
ʋ	r	ɾ	

Appendix C - Published article.

Heijkoop, A.C. (1997), 'Underspecification and contrast: consonant harmony in early phonological acquisition' in Sorace, A., C. Heycock and R. Shillcock, eds, *Proceedings of the GALA '97 Conference on Language Acquisition*, Edinburgh: Human Communication Research Centre, The University of Edinburgh, 235-39.

# Underspecification and Contrast: Consonant Harmony in Early Phonological Acquisition

Anita C. Heijkoop

Department of English Language  
The University of Edinburgh.  
elaahp@serv0.arts.ed.ac.uk

## Abstract

Consonant harmony is a characteristic of the early stages of phonological development, and underspecification is assumed to explain this aspect of the child's output. In particular, coronal underspecification is claimed to account for this tendency that the place of articulation of the consonants across the child's utterance is constant. Data analysis, however, suggests that the staging of the development of place of articulation can account for the harmony phenomenon. It points to (the absence of) contrast rather than underspecification as the source of consonant harmony. In this paper, both claims will be discussed, as well as their implications regarding phonological development.

## 1. Coronal underspecification

Studies that adopt coronal underspecification as an inherent part of the acquisition process of the phonological component of speech are Stemberger and Stoel-Gammon (1991), Rice and Avery (1995), and Levelt (1994). Stemberger and Stoel-Gammon (1991) is widely quoted for its discussion of coronal underspecification in adult and child language (see 2.). The model proposed in Rice and Avery (1995) is specifically aimed at accounting for phonological acquisition, and entails coronal underspecification as well (see 3.).

## 2. Assimilation processes

Stemberger and Stoel-Gammon (1991:190-91) present the following findings regarding harmony (on basis of the data from 33 children between 9-24 months (Stoel-Gammon 1985), and 18 children reported from the literature and unpublished diary studies): i) a bias towards replacing alveolars with velars in harmony, ii) a bias towards replacing alveolars with labials in harmony, and iii) the assimilation of velar to labial is as likely as *vice versa*. On the basis of this information concerning harmony processes, coronal is concluded to be different from the labial and velar place of articulation. The explanation for this special status is

claimed to be found in underspecification (alternative explanations, such as frequency and markedness, are rejected as inadequate) (1991:191-94).

Other types of evidence discussed regarding the status of coronal are relative order of acquisition of place of articulation, and fusion. With regard to the former, Stemberger and Stoel-Gammon (1991:188-89) refer to studies that state that alveolar and labial consonants occur at the same time in any position in the syllable. They conclude that it does not provide evidence for the different status of coronals. Fusion, or the merging of two adjacent consonants, is claimed to provide evidence for the absence of coronal in the underlying representation. For example, in the initial cluster /sp/, /s/ is specified for manner and not for place, and /p/ is specified for labial, thus resulting in [f] in the child's output (1991:191). However, as it does not refer to the actual system of phonological contrasts in the child's system at the time, this type of evidence is regarded here as invalid. The entire discussion in Stemberger and Stoel-Gammon (1991) concerning child language is carried on outwith the context of the phonological system of the children concerned, and the claims made can thus not be evaluated.

Also, the evidence quoted in relation to order of acquisition, in the form of references to other studies, appears on the whole to be inappropriate for the underspecification discussion. From a study of this secondary material, namely Stoel-Gammon (1985) and Vihman, Ferguson and Elbert (1986), it can be concluded this is concerned with phonetic observations rather than with phonological contrasts.

## 3. Feature geometry in acquisition

The proposal in Rice and Avery (1995) focuses on the acquisition of segmental representation within a feature geometry model, where 'the elaboration of segment structure [proceeds] along a predetermined pathway' (1995:24). The part of the feature geometry that reflects the specification of place of articulation is given in Figure 1 below (1995:31).

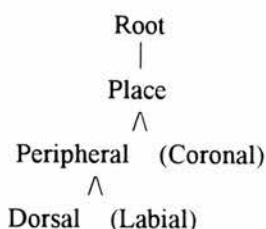


Figure 1: Place structure in Rice and Avery (1995)

At each bifurcation in the model proposed, one feature is redundant (indicated by parentheses) and one feature is not. Redundancy is related to markedness, and is defined as the ‘absence of unmarked features in the phonology’ (1995:33). Given that *unmarked is redundant* and *redundant is not specified*, the three main place of articulation are represented as follows (Figure 2) (1995:32):

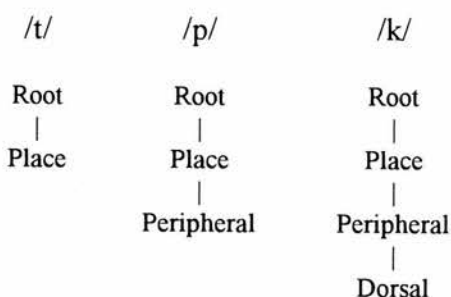


Figure 2: Representation of the main places of articulation for stops in Rice and Avery (1995)

The child’s learning path is ensured in the context of the feature geometry proposed by the monotonicity assumption, namely that the introduction of a newly acquired contrast in the system gives rise to the addition of structure in the form of a *single node* (1995:35). In the context of a phonological system with few contrasts, monotonicity is a logical consequence of the founding principle of feature geometry, which states that constituent nodes are motivated by the functional grouping of features (cf. Clements 1985). Following the model proposed in Rice and Avery (1995), the first contrast for place of articulation is between coronal and non-coronal (bare node v. *Peripheral*), the second distinguishes between the non-coronal places, labial and velar (*Peripheral* v. *Dorsal*). Given the assumption that a segment with less structure can assimilate to a segment with more structure (1995:32), the structure under the place node, which is motivated by adult assimilation processes as such, predicts that coronal assimilates to other places of articulation, and not

*vice versa*. This is in agreement with the claim generally made concerning the place assimilation processes during the acquisition process (leaving aside the relation between labial and velar).<sup>1</sup>

Variability in the child’s realisations is another aspect of early child language discussed in Rice and Avery (1995). ‘[T]he fact that little structure is specified’ (1995:38) implies that the phonetic space available for the free variants of a particular phoneme in a system is more comprehensive, resulting in non-contrastive variability. For instance, if the only contrast is between vowel and consonant, the child’s actual realisation of a consonant or vowel is not relevant from a phonological point of view (1995:36). Indeed, when place of articulation is not yet distinctive, a variable realisation of place is expected (1995:39).<sup>2</sup> The *Root-Place* sequence, without any dependent under the place node, however, is claimed to represent alveolar (in adult language); the coronal node is received by default rule (1995:32). Within the model proposed, there thus seems to be different interpretations of the bare place node. In adults, it represents a coronal, whereas during the acquisition process, it accounts for variable realisations. This difference could be explained by the acquisition of the default rule by the child in the course of the process of phonological acquisition. However, no account is given of how or why the child gets into possession of this rule to fill in the non-specified place node with coronal. This also implies that coronal is not innately the unmarked value.

With regard to the predicted acquisition order of place, the study referred to is a study of phonetic observations only, similar to the references used in Stemberger and Stoel-Gammon (1991). Ferguson and Farwell (1975:435), whilst presenting their results in the form of phone trees, note that ‘the phone trees show lexical contrasts rather than phonemic contrast’. It may be clear from this that the status as ‘first sounds’ of alveolars and labials does not imply a phonological contrast. Again, an inappropriate

<sup>1</sup> Rice and Avery (1995:34) quote Ferguson and Farewell (1975:435) (children have ‘labial and alveolar stops as their first sounds’) with regard to the prediction that the first contrast is between a coronal and a peripheral, i.e. /t/ v. /p/. Ferguson and Farewell (1975) assume the phone class /t ~ k/, though, and thus group alveolar and velar together, and not velar and labial, as do Rice and Avery (1991) (however, cf. footnote 2).

<sup>2</sup> It is not clear why Rice and Avery (1995:39) only mention a variation between coronal and labial here, and leave velar out of consideration.



reference is used in the discussion on underlying segmental representation (see 2). Furthermore, the model posits the prediction that the first articulatory contrast in the child's system is one between coronal on the one hand, and non-coronal on the other (cf. Levelt 1994). This, however, is not in agreement with the data findings from the ChildPhon child utterances (see 5.), which thus appears to disprove the segmental specification model proposed in Rice and Avery (1995).

#### 4. Summary

The assumption that coronal is underspecified in order to account for the assimilation processes that underlie consonant harmony is based primarily on phonetic observations that do not provide appropriate information about the phonological system of the child. Also, it does not explain why consonant harmony is a feature of child language and is characteristically not found in adult language, when the immediate cause, i.e. underspecification, is still present. An interpretational discrepancy of the bare place node between adult and child representation (coronal and non-contrastive variability, respectively) becomes evident in the Rice and Avery (1995) proposal for segmental acquisition. The acquisition of a default rule filling in coronal could explain the disappearance of consonant harmony from the child's system. However, this is not presented as part of the proposal.

#### 5. Acquisition of contrast

The study reported here concentrates on the data of

five children acquiring Dutch (monolingual), taken from the ChildPhon database (see 8.). These children (3 boys, 2 girls) were between 1;0.10 and 1;6.4 at the onset of the observation period. They were recorded fortnightly over a period of a year. (The recording sessions are numbered and indicated with '#'.) For each of the five children separately, only spontaneous (as opposed to imitated) utterances were taken into account. Subsequently, for each child, for each session, all phonemes were counted. Hereby, a distinction was made between initial, medial and final position. Apart from the nature of the phonemes in the actual realisations of the child, the target phoneme was also registered. On basis of this information, the phonological system for each session was reconstructed, applying the basic principles discussed in Grunwell (1985:37): i) phones which consistently function contrastively to signal meaning differences are the contrastive phones, and ii) phones which appear to occur in free variation at the same place in structure are phones which are non-contrastive variants of a phonologically contrastive phone. With respect to the second point, the variable realisation of an adult target phoneme is referred to as non-contrastive variability (1985:78) (cf. Rice and Avery 1995).

The main aim of the data analysis was to reconstruct the development of the phonological system of the five children, on basis of their successive systems. The reconstructed evolution of the underlying system of one of the children, Robin (1;4.14 - 2.4.28), is presented in Figure 3 (*lab*=labial, *alv*=alveolar, *vel*=velar, *fric*=fricative).

nasal stop continuant	#1	lab nasal    nasal lab stop    stop lab fric    fricative liquid	#15
nasal stop fricative liquid	#6	lab nasal    nasal lab stop    stop lab fric    fricative lab liquid    liquid	#19
nasal lab stop    stop fricative liquid	#8	lab nasal    nasal lab stop    alv stop    vel stop lab fric    alv fric    vel fric lab liquid    liquid	#20
lab nasal    nasal lab stop    stop fricative liquid	#14	lab nasal    alv nasal    vel nasal lab stop    alv stop    vel stop lab fric    alv fric    vel fric lab liquid    liquid	#21

Figure 3: Development of phonological contrasts (Robin, 1;4.14-2.4.28)

Adult target		Child realisation (<#20)		(≥#20)
'clown'	/klaun/	<i>clown</i>	#8 ['dœn] #10 ['tœun]	<i>clowntje</i> (dim.) #23 ['kœrtjə]
'table'	/tafel/	<i>tafel</i>	#13 ['pa'fy]	
'to swim'	/zʷemə/	<i>zwemmen</i>	#13 ['fɪm'ə]	
'soap'	/zɛp/	<i>zeep</i>	#13 ['fɪp]	#23 ['sɛp]
'sweet' (dim.)	/snupjə/	<i>snoepje</i>	#16 ['fupi 'supi]	
'seven'	/zɛvən/	<i>zeven</i>	#16 ['fɪf'ɪ]	
'soup'	/sup/	<i>soep</i>	#16 ['fup]	#21 ['sup]
'look'	/kɛik/	<i>kijk</i>	#17 ['tɛik]	#22 ['kɛik]
'a guitar'	/ən χitaɪ/	<i>een gitaar</i>	#18 [ʔe' sɪta:]	
'captain'	/kapitein/	<i>kapitein</i>	#18 ['p'apɪtɛin]	
'to come'	/kɔmə/	<i>komen</i>	#18 ['p'u:mə]	<i>komt</i> (3rd, sing.) #20 ['kɔmt]

Figure 4: (Harmony) forms in the output of Robin

## 6. Consonant harmony and the development of place

From the development of Robin's phonological system (see Figure 3), as well as from the reconstructed development of the four other children, the pattern that emerges cross-category is that the first place contrast is between labial v. non-labial (Robin: #8 stops, #14 nasals, #15 fricatives), giving rise to a specification for labial and a non-specified non-labial unit. For all children, the second contrast is between alveolar v. velar (Robin: #20 stops and fricatives, #21 nasals).

The harmony forms that occur in Robin's output (#8-24) are presented above (Figure 4), together with later occurrences of the same words. The bold vertical line indicates #20, when a three-way contrast between labial, alveolar and velar has established. Three different types of realisations can be observed amongst these (harmony) forms:

1. At a time when there is no contrast between alveolar and velar (<#20), these two places of articulation are in free variation, i.e. non-contrastive variability (*clown*, *kijk*, *een gitaar*).
2. During the same period (<#20), target velar and alveolar consonants are realised by the child as labial. This can be accounted for by the contrastive status of labial that is consequently specified for place, whilst velar and alveolar are unspecified. Spreading can take place from a labial segment to a non-labial, non-specified segment. In the forms with a labial realisation (*tafel*, *zwemmen*, *zeep*, *snoepje*, *zeven*, *soep*, *kapitein* and *komen*), a labial segment is present that can spread to an empty slot; labial filling-in. The optionality of this process is demonstrated by the realisation of *snoepje* with both an initial

alveolar and labial consonant, and by the realisation of an initial velar target as alveolar (*kijk*, *een gitaar*) and labial (*kapitein*, *komen*).

3. After #20, however, labial spreading to target velar and alveolar is no longer observed. They are realised as velar and alveolar, respectively. This follows naturally from the development of Robin's phonological system, as all three places of articulation are stabilised and specified during and after #20, and thus there are no empty place slots to be filled in.

From this discussion of the (harmony) forms in Robin's output, and the comparable observations in the output of four other children, it becomes clear that consonant harmony or place assimilation processes are motivated by lack of contrast. If there is no contrast between the places of articulation, these are not specified (non-contrastive non-specification), and spreading from a segment that is specified for place is possible. Once all place contrasts are established, and the three main places of articulation are underlyingly present, there are no empty place slots available, and place assimilation is no longer characteristically present in the child's output. Consonant harmony is thus concluded to be a system-internal, regular phenomenon.

## 7. Conclusion

On the basis of the harmony forms of five children acquiring Dutch and the development of their phonological system, consonant harmony is concluded to arise from lack of contrast, and subsequent filling-in of segments that are not specified for place of articulation. Non-contrastive non-specification is claimed to provide a more insightful and straightforward account of consonant

harmony than coronal underspecification. Proposals that employ underspecification are also rejected on basis of their predictions regarding the order of place acquisition (based on phonetic studies of acquisition), as these do not agree with the data observations. Coronal is not the first acquired contrastive entity in the child's phonological system. Moreover, coronal underspecification does not explain the transition from child language to adult language, given that consonant harmony disappears from the child's output, when coronal is assumed to be underspecified in the adult phonology as well. A system-internal explanation referring to the limited number of contrasts in the child's system that increases in the course of the acquisition process can account for the transition; when all major places of articulation are specified, free variation and labial filling-in will no longer occur. The analysis of the data here shows the invalidity of the approach to language acquisition that extends findings concerning adult language to child phenomena.

Adopting the non-specification explanation of consonant harmony also implies the assumption that (coronal) underspecification is not present during the early stages of acquisition. The literature consensus, however, is that coronal is underspecified (most notably advocated in Paradis and Prunet 1991), which is mostly illustrated by means of adult language. In this context, various basic questions arise: what is the motivation to implement underspecification in a phonological system, and what is the mechanism that introduces underspecification in a fully specified system. The majority of the coronal underspecification accounts appear to adopt a universal attitude to place specification, contrary to the language-particular underspecification basis proposed in Archangeli (1984, 1988). Exceptions are Stemberger and Stoel-Gammon (1991:193) who suggest phone frequency as the underlying factor of underspecification, and Anderson and Durand (1988) who tentatively propose universal (system-dependent) geometrical principles. The question regarding motivation and mechanism of underspecification is largely ignored in the child language accounts that adopt coronal underspecification. The implementation of underspecification after the consonant harmony period requires further investigation.

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